would seem that in the experimental ranch the small number of litters is to be ascribed to the impotence, permanent or transient, of the males. We have no evidence that fertility is dependent on diet.

By far the finest of the three litters raised was that of the vixen upon a low calorie-low protein diet. As already stated, this animal in the previous season produced a litter upon a high caloric diet; but she had then very poorly developed milk glands and she killed the litter a day or so after its birth. This year she developed very large udders and had always an abundant supply of milk. The pups, four in number, grew at a rapid and uniform rate, and at four weeks were 20-50 per cent heavier and 16-25 per cent longer than pups of the other litters. At four months they exceeded the mother in length and weight. The other two mothers, who had been fed high-calorie diets, were less successful. They had poor appetites during the lactation period, and produced less milk. Their litters (numbering four and five pups), grew slowly, and at four months were still about three weeks behind normal; in spite of the fact that the parents were bigger than those of the first-mentioned litter. It would seem therefore that the diet of the mother during gestation had a striking influence upon her subsequent success in rearing progeny. The results of both seasons agree in emphasizing the harmful effects of overfeeding, and in indicating 100 calories per kilo as the proper ration for the pregnant fox. The optimum protein content of the diet is not so clearly defined; but something between 1·2 and 1·5 grams nitrogen per kilo appears to be a safe allowance.

In order to make sure that the vixen secures neither more nor less than her prescribed ration, the committee considers it advisable that during pregnancy she should be isolated from the male.

With the three litters available an attempt was made to determine experimentally the food requirement of the lactating mother. It is known that growing dogs require for every 1.000 grams of growth from 7.000 to 9.000 calories of ingested food. It was therefore planned to observe the effect upon the three litters of feeding the mothers respectively 5.000, 7.000 and 9.000 calories (in excess of their maintenance requirement), for every 1.000 grams of growth normally to be expected in the offspring. Unfortunately it was only in the case of the fox fed at a 9.000 level that the ration was quantitatively consumed; this being the fox which had been fed during gestation a low-calorific diet. In spite of this it was found that the ratio of growth in the litter to extra food consumed by the mother was practically constant for all three families during the first eight weeks; each kilogram of gain on the part of the sucklings corresponded to the ingestion by the mother of 8.800, 8.400 and 8.800 calories respectively in excess of her maintenance requirement. This agrees with the recorded data for growing dogs, and obviously furnishes a basis from which it will be possible to calculate the actual requirement during lactation of any vixen.

It may be noted in passing that opportunity was taken to analyze the milk of two of the nursing vixens. The following data were obtained:—

Fox number	26	26	8	Average
Days after partuition	28	35	28	
Total solids..Per cent	22.81	20.94	18.02	20.59
Ash "	1.204	0.942	0.919	1.022
Fat (ether extract) "	12.03	10.9	7.91	10.28
Total N. "	1.496	1.325	1.114	1.302
Total protein "	9.36	8.46	7.14	8.32

Attention has been given also to the question of the food requirement of the growing pup after weaning. The data so far accumulated are not sufficient to justify a positive statement upon this head, but indicate that a ration beginning at 250 calories per kilo and diminishing gradually to 120 will in general satisfy the requirements of the five months during which growth continues. The gain in weight of the pups has been found, as might be expected, to be proportional

to the caloric value of the food ingested. The ratio between these factors, for the first litter raised on the ranch, was 1 to 12 for the third month, 1 to 15 for the fourth and 1 to 42 for the fifth, during which growth was slowing up.

It is satisfactory to be able to record that the litter produced in 1921 has shown excellent results as regards the quality, and especially the colour, of the fur.

The fur had a clear jet-black or silver-black colour and an excellent silky lustre and even at the end of the winter did not show any signs of going off colour, which was in very marked contrast to the parents and the other foxes. Fox breeders have made a practice of pelting early in the season before the fur and hide have really reached their prime because the fur goes off colour. Also many foxes acquire a brown shade long before they could possibly be pelted. If the result obtained with these pups can be reproduced, the source of a great loss of revenue to the fox industry will be eliminated.

During the year a bulletin on the food requirements of the ranch fox was published. The biochemist in charge of the experimental ranch also co-operated with the animal pathologist in charge of the Fox Research Station of the Health of Animals Branch of the Department of Agriculture at Charlottetown, P.E.I., in preparing a bulletin, to be published by that department, on Fox Ranching in Canada, with special reference to the construction management and sanitation of ranches and diseases and nutrition of foxes.

It is intended to puhlish a pamphlet containing the diets of a ranch fox, the live weight and measurements of a fox pup at different ages and other information which might be contained on a single page; such as could be tacked up in the place where the food is prepared.

APPENDIX D

REPORT OF THE ASSOCIATE FOOD RESEARCH COMMITTEE FOR THE YEAR 1921-22

The Committee begs to submit the following report regarding the investigation of the water soluble vitamin content of rich polish undertaken by it.

The investigation has been carried out for the past year in the Laboratory of Food Chemistry, Household Science Building, of the University of Toronto. The work has been largely under the supervision of Professor C. C. Benson of this department, and Dr. A. Bruce Macallum. It was found necessary to employ paid assistants up until the end of June, 1921, but since October of the current year the work is being carried on by two female assistants in the Department of Food Chemistry who are devoting all their time not otherwise engaged in teaching to the prosecution of this work. These assistants will be available until the end of June, 1922.

A study of the vitamines has been undertaken with the investigation of the vitamin content of rice polish. This material is readily procured in large quantities and the study already made upon its antineuric vitamin supplies a good basis upon which to work while the methods recently announced of estimating the amount of water soluble vitamin in extracts by means of its effect upon the growth of yeast cells in artificial culture media afford a satisfactory method of testing the strength of these extracts. The efforts of the subcommittee have therefore been engaged in, first, investigating the various methods of determining the vitamin, in which the rate of growth of yeast cells on artificial culture media is used as the indicator. The method as used by Bachmann by determining the amount of gas produced by the growth was found to be inaccurate owing to the varying rate of absorption of the gas by the culture media. An alternative method by which the yeast cells were filtered

off, dried and weighed, was also found to have certain objections in that it was very tedious and time consuming. The method as used by Funk in which the yeast cells were grown on artificial culture media and the increment of growth measured by centrifuging in a specially constructed centrifuge tube with a capillary at the bottom, measuring the rate of growth by the height of the yeast cells in the capillary, was found to be the most suitable. It was found, however, in the course of incubating the yeast on the artificial culture media that uniformity of growth could not be readily obtained in all cases where conditions as to the quantities of culture, vitamin solutions, etc., were identical. Some weeks were taken up in an effort to ascertain the reason for this variation in growth, but fortunately some of the workers in the University of Toronto in the Department of Physical Chemistry had studied this problem and were kind enough to give the sub-committee all the details necessary for the solution of this question. This, however, involved the construction of a special piece of apparatus which was not installed and set in working order until the end of June. During the Summer months the work was not carried on owing to the fact that the laboratories in which the experiments were being undertaken were closed. Work, however, was recommenced in the middle of September and is now in progress.

Realizing that the old methods utilized in separating out the vitamin from the rice polish by means of metallic salts and acids have not led very far, the question of separating out the adventitious material by means of various solvents has been investigated. The rice polish is extracted with a dilute aqueous solution of acetic acid from 1/10 to 1 per cent in strength, concentrated to dryness and the residue fractionated with alcohol of various strengths. In this way about 75 per cent to 85 per cent of the adventitious material in the extracts have been removed and a highly concentrated solution containing the active vitamine has been obtained. A large number of experiments have been carried out on the optimum conditions for extraction, and the behaviour of such conditions as temperature, acidity, alkalinity, etc., on the rate of destruction of the vitamin.

The committee proposes during the coming year to carry out the concentration of the vitamin solution already obtained on a small scale, on a much larger scale and will endeavour to obtain solid residue which will yield a water soluble vitamin in its maximum purity obtainable by these methods. Investigations now under way are being carried out with reference to the use of various grades of alcohol as already mentioned, and with regard to the use of such commercial solvents as butyl alcohol, amyl alcohol and esters of these compounds. Furthermore, these concentrates will be tested as to their colour reactions which will be developed by means of diazotizing the vitamin so that its solutions coupled up with a number of dye stuffs intermediates will give specific colours for certain groups. In this way it is hoped to obtain some insight into the constitution of the compounds associated with a fairly pure vitamin residue and even perhaps of the vitamin itself.

As the residue obtained by the methods stated above is extraordinarily small the ordinary analytical methods of organic chemistry are useless for the identification of its constituents. Professor Chamot, of Cornell University, has published a work recently embodying the use of a specially constructed microscope by means of which the character and constitution, melting point, refractive index and other physical and chemical constants of very small amounts and even one or two minute crystals may be determined. It is proposed to use these methods in the further prosecution of the research. The committee also expect through the courtesy of the Physical Department of the University of Toronto to be able to ascertain the effect of such conditions as low temperature by means of liquid air, and the effect of liquid oxygen, etc., on the stability of the vitamin.

APPENDIX E

REPORT OF THE ASSOCIATE AIR RESEARCH COMMITTEE FOR THE YEAR 1921-22

The Air Research Committee has, on the advice of the technical officer of the Air Board, concentrated its attention more particularly on those problems peculiar to Canada, and chiefly to the starting of machines at low temperatures during the winter months.

This work has been undertaken at the University of Alberta by Professor Robb, who has investigated the effect of low temperature on combustion, lubrication, and cooling. Good progress has been made, but the effect on the carburetor has still to be determined.

Professor McKergow, McGill University, has ascertained the physical properties of the principal anti-freeze mixtures which are on the market.

Professor Stanley Smith, of the University of Alberta, and Mr. W. C. Way, Department of the Interior, Ottawa, are investigating improvements in the aneroid barometer and altimeter which are subject to errors of backlash and hysteresis.

Professor Bronson, of Dalhousie University, is investigating the effect of low temperature on rubber used in aeronautical instruments. This is a wide field which requires further workers.

Professor J. H. Parkin, of the University of Toronto, has carried out numerous experiments with the wind channel which is the property of the University of Toronto. He has calibrated the instrument and improved the intake so as to obtain a uniform flow of air in a building with numerous obstacles. He has investigated the best form of wing tips, and, in conjunction with Mr. J. T. Patterson, of the Meteorological Office, experiments have been carried out on the rotating cups of the anemometer. This instrument, used all over the world by meteorologists, is not accurate, and an improved type may be recommended on the results of Mr. Patterson's investigations. The above and other work has been carried out by those named above without payment for their valuable services. Moderate grants have been made for the purchase of necessary apparatus and in one case for the assistance of a mechanic.

The committee desires to acknowledge its appreciation of the wise guidance of Colonel Stedman.

APPENDIX F

REPORT OF THE SPECIAL COMMITTEE ON NITROGEN FIXATION

The appointment of this committee was made early in 1917.

The personnel of the committee is as follows:—

Professor J. C. McLennan, O.B.E., D.Sc., F.R.S., Convener.
The Chairman, ex-officio.
Professor A. B. Macallum, D.Sc., F.R.S.
Professor R. F. Ruttan, D.Sc., F.R.S.C.

In the absence of any definite appropriations by the Government for research work on nitrogen fixation, the work of the committee has so far been confined, necessarily, to the collection of data relating to this highly important subject and to the making of periodical reports indicating the progress which is being made in different parts of the world.

Up to the present time seven such reports have been made:—

Report No.	Date
I	April, 1917.
II	January 1, 1920.
III	April, 1920.
IV	May 17, 1920.
V	October 23, 1920.
VI	April 11, 1921.
VII	February 3, 1922.

As the present report is the first one to be issued by the Nitrogen Fixation Committee for publication in an Annual Report of the Administrative Chairman of the Council, a reference to each of the reports made prior to 1921, as well as to that covering the past year, will not be out of place here.

Report No. 1. April, 1917.

The first report of the Nitrogen Fixation Committee consists of copies of correspondence which passed between the convener and various authorities, in which the former was endeavouring to obtain information that would help the committee and to set forth to the British Government the possibilities of manufacturing nitrogenous products in Canada. It closes with a bibliography of the literature of the subject. An appendix to this report contains a copy of an interesting lecture by Professor Crossley in England on the Utilization of Atmospheric Nitrogen; various extracts from *Engineering* (London) on nitrogen fixation; a summary of data gathered by the Hydro-Electric Power Commission of Ontario, and a fairly lengthy bibliography of the subject.

Report No. 2. January 1, 1920.

This is one of the most important that has yet been issued as it deals in a very full manner with nitrogen fixation matters during the War period and includes many valuable data taken from the Interim and Final Reports of the British Nitrogen Products Committee, which, at the time, were confidential. Other matters covered in the report are the status of nitrogen fixation in the United States and Canada, the information in this case being obtained direct from the foremost authorities in the respective countries.

Emphasis is laid on the need for collecting and tabulating all available statistics regarding this extremely important subject and on the fact that Canada's water-powers ought to enable her to stand in the very forefront in regard to nitrogen fixation, particularly so far as supplies of combined nitrogen needed within the Empire are concerned.

A bibliography of over 130 papers and documents, some of them of a highly confidential nature, which were transmitted to the chairman, is included.

The report concludes with four appendices:—

I. A few data regarding the American Nitrogen Products Company operating the Arc process in British Columbia.

III. An article (in French) copies from *Comptes Rendus* of December 1, 1919, describing the (then) recent work of M. Claude on the synthesis of ammonia.

II and IV. Appendices II and IV are copies of a Bill that was laid before the United States House of Representatives and the United States Senate in 1919, proposing the establishment of a Federal Agency "for the manufacture, production and development of the products of atmospheric nitrogen."

Report No. 3. April, 1920.

The first portion of this report consists of a copy of a circular letter that was sent out to many persons in the Dominion qualified to speak with authority on either the manufacture or the use of artificial nitrogenous fertilizers. The

letter set forth the subject in a general way as it affects this country and requested comments on the whole situation with reference to Canadian conditions.

Brief synopses of various items of information collected from technical publications, concluded this report, which is only a short one.

Report No. 4. May 17, 1920.

The replies received to the circular letter referred to above are synopsised in this report. The information thus obtained is of a valuable character and indicates that a good deal of interest is taken in the subject by those who realize its importance.

Following the above are various data taken from technical journals which indicate the trend of events in various countries. The report concludes with a summary of the information furnished, together with notes as to the outstanding points so far as they relate to Canada.

Report No. 5. October 23, 1920.

This report gives a few data regarding the world's natural supplies of the nitrates of sodium and potassium; some notes on the dye industry, which in war time can be turned to good account for nitrogen fixation; some valuable information regarding nitrogen fixation in the British Empire that was obtained from Dr. Harker, at that time Director of Research for the Munitions Inventions Department of the British Ministry of Munitions; and also notes on nitrogen fixation in the United States.

The most noteworthy part of this report is a report from Dr. Harker on the Claude process for the synthesis of ammonia which was then being developed in France.

Report No. 6. April 11, 1921.

General information regarding progress in various parts of the world is the outstanding feature of this report. The very great importance that Germany attaches to the subject of nitrogen fixation is noted in an article in the *Times Engineering Supplement* which states: "It is common knowledge that Germany intends to raise her production of nitrogen to two and a half million tons per year."

Report No. 7. February 3, 1922.

This report covers a longer period of time than most of its predecessors, and, as it is the most recent, deserves special mention here as bringing the whole subject practically up to date.

Some of the information in this report is of very considerable importance. the principal matters coming under this heading being as follows:—

1. A review of the Statistical Supplement to the Final Report of the (British) Nitrogen Products Committee which was compiled by the Dr. Harker mentioned above in connection with Report No. 5 and was published in 1921. This supplement which is obtainable from H. M. Stationery Office in London, England, gives statistics regarding the fixed nitrogen resources of all countries. Germany of course leading all others by a very wide margin. In fact, all other countries combined do not quite equal Germany's standing in this respect. A copy of the supplement is one of the appendices to the report.

2. A very considerable amount of detailed and highly useful information regarding the Claude process, which shows signs of becoming a formidable rival of the Haber process came into the hands of the committee during the period covered by the report. This consisted of two reports from Dr. Harker and a pamphlet in French by M. Claude himself, copies of all three form appendices to the report.

3. In September, 1921, occurred one of the worst disasters due to explosion in the world's history when the German village of Oppau was practically destroyed, and the great chemical works where the Haber process was in operation suffered very severely. Nearly 200 lives were lost and the property damage was estimated at about 175,000,000 marks.

It is noteworthy that no really satisfactory solution of the cause of this explosion has yet been offered although many theories were advanced both by investigators on the spot and by many chemists of note in other countries. This being the case, it was thought advisable for the guidance of future investigators in Canada, to collect all possible data relating to the Oppau explosion and these are embodied in the report.

4. Details of some interesting experiments by two chemists in England on the manufacture of artificial farmyard manure were published in 1921 and these are reviewed. The publications (two) form appendices to the report.

The remainder of the report consists of miscellaneous items of interest relating to nitrogen fixation in those countries where the subject is being pursued, viz: England, Canada, United States, Germany, Italy, Norway, Austria and Russia. Some notes regarding Chile and its nitrate industry are also included.

The report concludes with a summary and a fairly extensive hibliography of recently published matter.

Summing up the whole subject of nitrogen fixation it may be said that the war greatly stimulated interest in the subject in all civilized countries and that although, of course, there is not the feverish activity to build huge plants and develop new processes that there was during the period of hostilties yet in England, France, Italy and Germany a good deal of work is still going on in actual building of plants, in addition to research work, while in the United States the Fixed Nitrogen Research Laboratory is apparently working very hard on research work. It is unfortunate to have to record that, of all the countries named, Canada is apparently doing the least, notwithstanding that the demand for artificial nitrogenous fertilizers will become of increasing importance as time goes on; that Canada's possession of vast water-powers gives her an advantage of immense value; and that her geographical location as one of the constituent nations of the Empire places her in a peculiarly favourable position for serving the needs of the Empire in war time.

Of course, owing to the after effects of the war and to the fact that her population is small and her aggregate wealth is not yet large, as well as to the fact that, at present, the home market for nitrogenous products is not of very great proportions, it is hardly to be expected that Canada should be actively engaged in large schemes for increasing her facilities for the manufacture of nitrogenous products, but it is much to be regretted that research work is receiving little or no attention either from private enterprise or from the Government.

In lieu of better things the Nitrogen Fixation Committee feels that its labours, in collecting and tabulating a very large amount of information on this most important subject, though not of much present utility, will ere long prove of very great worth, and so long as it is permitted to do so it will continue this comparatively humble but necessary work in the sure confidence that nothing but good can come of its efforts.

APPENDIX G

REPORT TO THE ADVISORY COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH OF CANADA ON THE MEETING OF THE INTERNATIONAL RESEARCH COUNCIL HELD IN BRUSSELS IN JULY, 1922.

Your chairman during the past summer attended the Second General Meeting of the International Council of Research. This took place in Brussels during the week of July 25 to July 29.

It will be remembered that the First Meeting of the International Research Council was held in the year 1919. The meetings last summer were held in the magnificent Palais des Academies,, situated on the Place du Tône.

Twenty countries are members of this International Research Council, and sixteen of these countries were represented at this meeting. Germany, Austria and Russia were not represented, the first two mentioned were not invited.

The number of representatives present somewhat exceeded one hundred. Professor Picard of Paris—as President—took the chair. Sir Arthur Schuster was Secretary.

Great Britain sent eight delegates, the United States ten delegates, while the various Latin countries had large delegations. Your chairman was the only representative present from Canada.

The Executive Committee reported that since the last meeting Denmark, Spain, Mexico, the Principality of Monaco, Norway, the Low countries, Sweden and Switzerland had joined the Council (these are included in the twenty countries referred to above as members of the Council).

The following members, which are not members of the General Council, have been accepted as members of certain of the Constituent Unions of the Council: Argentina, Brazil, Czecho-Slovakia, Roumania, South Africa, and Uruguay.

The following Unions of the Council are now definitely established:—

The International Astronomical Union.
The International Union of Geodesy and Geophysics.
The International Union of Pure and Applied Chemistry.
The International Union of Mathematics.
The International Union of Radio Telegraphy.

The formation of similar Unions in the Department of Physics, Biological Science, Geology and Geography were under consideration by the Congress.

The Executive Committee reported that meetings of the International Astronomical Union, and of the International Union of Geodesy and Geophysics have been held at Rome on the 2nd of May, 1922, and that three meetings of the International Union of Pure and Applied Chemistry have been held as follows:—

June, 1920, at Rome.
June, 1921, at Brussels.
June, 1922, at Lyons.

Certain matters concerning the further organization and development of the International Council of Research were considered by the Council. Among these the following may be mentioned:—

No. 1. A proposal that the International Union of Biological Sciences. provisionally approved of in 1919, should be replaced by two separate Unions. one of Biological Sciences, and the other of Medical Sciences.

The decision on this question was left to the International Union of Biological Sciences, with power to take such action as it saw fit.

No. 2. The delegates from the United States brought forward a motion that in order to procure the effective co-operation between the International Research Council and the separate Unions, and further to develop local interest in international and scientific affairs, it was advisable that while retaining the legal seat of the International Research Council at Brussels, the Executive Committee be authorized to arrange for the holding of the Triennial Meetings at such places as may seem most advantageous. This proposal after debate was withdrawn on the understanding that it might be brought up for consideration later if occasion required.

No. 3. It was suggested that the International Research Council should organize international research projects requiring the co-operation of several branches of science. The energy supply of the world (fuel, solar energy etc.) was suggested as a promising field of international research. Action on this matter was left to the Executive Committee.

No. 4. The Swedish representatives proposed that the Statutes of the International Research Council should be altered as soon as possible so as to permit of the admission of all nations to the Council and its Unions.

After an animated discussion, it was decided that this motion should be laid on the table, and that the Council pass on to the order of the day.

There were two meetings of a temporarily appointed committee on Geology to consider the establishment of a Geological Section. Professor Lacroix was president and Mr. Renier acted as secretary of this committee.

Dr. Matthews represented the United States; Colonel Lyons, Great Britain; Dr. Stephani, Italy; Dr. Yamasaki, Japan; your Chairman, the Dominion of Canada, with ten other members as delegates from other countries.

The committee decided to draw up and submit to the International Geological Congress, which was to meet in Brussels some two weeks later, a scheme under which the latter, while retaining its identity, might be taken over as a Geological Union of the International Research Council.

It may be mentioned that while this was adopted by the International Research Council it was not regarded favourably by the International Geological Congress, which did not desire to run any risk of losing its freedom of action which might be curtailed should it join the organization of the International Research Council.

The International Geological Congress will continue, therefore, to remain an independent body.

The financial committee of the International Research Council submitted the following general statement covering the past three years:—

1919..	.....	£173.15.11
1920..	£240.17.11	631.13.10
1921..	294. 1. 9	71. 4. 8
	£534.19. 8	£876.14. 5

There was, therefore, a deficit of £341.14.9 during the first three years of the Council's operations. This was due in part to the fact that there were no receipts in the year 1919. This deficit was covered by two donations, one from the Royal Society of London, amounting to some £350 and the other from the National Academy of Sciences of the United States, amounting to £100.

On the 13th of July, 1922, the International Research Council had a favourable bank balance, amounting to £243.5.6. The resources of the Council will be sufficient to meet its expenses during the coming three years if the franc preserves its present value. It was decided that for the convenience of the Treasurer of the Council the nations contributing to the Council should be asked to deposit their dues with this officer not later than October 1, of each year.

APPENDIX H

The following Report was submitted by the LIGNITE UTILIZATION BOARD OF CANADA for the information of the Honorary Advisory Council for Scientific and Industrial Research.

PROGRESS REPORT No. 25

MONTREAL, December 8, 1922.

Progress Report No. 24 was issued as at July 3, 1922. The present report proposes to cover the development of the board's work from then to date.

Progress Report No. 24 outlined the progress that had been made up to the beginning of July in the reconstruction of three of the retorts, and mentioned that completion of construction was expected by the middle of August. These expectations were not quite fulfilled, and it was September 8 before the first trial run on a carbonizer was made. The next run was made on September 9, the third on Septemher 15, the fourth on September 18, and a long run (of approximately a week) started on September 25. Mr. Edgar Stansfield, the consulting chemical engineer of the board, was present at all these runs. All the trials were made with No. 1 carbonizer which is the retort reconstructed with hollow carbofrax tile. Owing to troubles with the exhauster (hereinafter discussed) it was not possible to institute comparative trials on retorts Nos. 3 and 5. It must be remembered therefore that the subsequent remarks herein apply only to carbonizer No. 1. It is highly probable that carbonizers 3 and 6 will work equally successfully from the point of view of operation. Their capacities still remain to be proved.

At the request of the chairman the writer proceeded on November 14 to the West to make an inspection of the work to date, and to confer with the two provincial Premiers. As a result of this personal study the board wishes to state that:—

By the completion of the fifth run practically perfect operation of the carbonizer had been obtained. Lignite was carbonized regularly and every interruption encountered could be accounted for clearly without any doubt existing as to its cause. Except for exhauster troubles, no outstanding difficulty was met with to prevent the board from carbonizing lignite continuously in this apparatus, with, however, the possible exception of cracks which have developed in the floor material. It will be recalled that in the trial runs of 1921 this was one of the fundamental difficulties encountered, but the manufacturers were insistent that a large improvement had been made in the quality of their product. It is too soon yet to report that the new carbofrax material is a failure. On the other hand, we are disappointed and somewhat anxious that cracks should be developing so soon. It is probable that further cracking may be prevented when operating the carbonizers continuously in the near future. .nd it is quite possible that the cracks may be due to the very hard treatment what necessarily was present when testing No. 1 retort. In other words, the constant heating and cooling might easily be more than any fire brick construction could withstand.

The difficulties encountered in operation were in the main chargeable to the exhauster. When any attempt was made to bring the combustion chamber up to high working temperature, the amount of gas produced became too great for the exhauster to pull away. This condition was very baffling until it was discovered that the apparatus furnished to the board was not in conformity with the specifications for same originally approved by the Lignite Board.

This discrepancy could only be made evident upon operation—and when so disclosed, steps were taken to hold the vendors responsible. A written admission of this responsibility together with a written agreement for replacement of apparatus was thereupon obtained. Before the vendors could complete this order, and effect shipment, they went into temporary liquidation, and the matter is being handled now by the board's lawyers. In order not to hold up the work the board has, in the meantime, placed orders for changes and revisions, assuming responsibility of payment themselves. The new motor for exhauster and small steam turbine for driving the machine are now on the way to Bienfait and will be installed within a short time.

To sum up the board states that:—

(*a*) It does not regard the work done to date on No. 1 retort as having proved complete success. On the other hand it is a long way from failure. A retort may be looked at from three points of view. Does it operate? Is the design as nearly correct as present knowledge enables it to be? And thirdly—is the capacity commercial? It is self evident that failure from the first mentioned point of view would spell complete disaster for any retort. From this point of view it can be stated that our No. 1 retort is a success. In other words, it operated for a long period with no serious interruptions to flow of coal, etc. The only qualification of this general statement lies in the possible breakdown of the carbofrax floor material to which reference has been made already. This achievement is a distinct advance gained over last year's work. From the point of view of design, we feel that the amount of research work done by Mr. Stansfield and others, since the construction of this retort, would enable us to prepare to-day a superior design, both as regards economy of heat and transference of same to lignite coal in passage. Under remaining head of capacity, the Board is disappointed with the showing made to date, which is briefly that the discharge is only about 50 to 60 per cent of what it was calculated to be. In addition auxiliary fuel was necessary owing to the large amount of heat that is diverted to the rotary dryers. The figures on capacity are subject to some improvement, and perhaps to a very marked improvement, when our exhauster troubles are solved, and when three or more carbonizers are in operation in parallel. Condensing the Board's opinion on the question of carbonizing, we would say that we have not yet achieved success, but we are a long way from failure. In other words, enough success has been achieved to warrant us in recommending the prosecution of the programme hereinafter referred to.

(*b*) In the departments of raw lignite handling, drying, briquette cooling, briquette storage, power plant, water supply, housing and sewage disposal, the Board would report that everything is in reasonable condition though as yet it has been impossible to undertake full duty trials.

(*c*) In the department of briquetting the board is not at all satisfied with the layout which it possesses at Bienfait, but is of the opinion that successful briquetting can be accomplished there, and that major revisions should only be undertaken when the fuller knowledge that hard continuous operation will produce, becomes available.

In view then of the above situation, the board proposes to recommend at the forthcoming conference, that an operating period of from four to six months' duration be entered upon immediately, even though such operating cannot, in the nature of the case, be termed fully commercial. The reasons for this are that cost for operating will necessarily be high per ton of output, and sale of the product cannot be expected to meet full charges incurred. In spite, however, of this fact, the board feels that only by undertaking such a step can the project be moved forward.

Owing to the long delays in connection with this work, owing to the fact that complete success has not been achieved at date of writing, owing to the

natural desire of the responsible Governments that they be fully acquainted with the situation, and owing to the desirability of pooling of ideas re future action in regard to the lignite work, the Honourable Mr. Dunning suggested to Mr. Camsell that a consultation be held between the Federal Government, the two Provincial Governments and the Lignite Board. With this suggestion the Lignite Board is in thorough accord, and on Wednesday last the writer proceeded to Ottawa to discuss the date of conference with Mr. Camsell, when December 21 or 22 was suggested tentatively. The chairman of the board is a member of the Hydro-Electric Inquiry Commission of the province of Ontario. This commission has sat continuously since last April, and owing to the importance of the work and the continuous nature of the sittings, it is out of the question for Mr. Ross to leave for a western meeting for some little time. Mr. Camsell also stated that he could not go to the West until well on in January. Under these circumstances it would appear to be advisable that the meeting be held in the East, especially as Mr. Bracken stated to the writer that he could not attend the meeting if held after Christmas, owing to the fact that his session started on January 1. It is hoped that before this report reaches the hands of its readers, that the above mentioned date may be fixed upon for an Ottawa meeting.

In the interval the board is making the changes in its exhauster, and arranging for a large scale test on the Hood-Odell retort. This retort is one that has been developed within the last few months by the Bureau of Mines, Washington, and seems to the board to be a very important and distinct advance in the art of carbonizing when lignite char is the main objective. The board is also making minor adjustments and changes in the briquetting building, in order to smooth out as many difficulties as possible.

All of the foregoing is very respectfully submitted.

(Signed) LESSLIE R. THOMSON,
Secretary.

APPENDIX I

REPORT OF THE COMMITTEE OF THE HOUSE OF COMMONS, APPOINTED TO CONSIDER THE MATTER OF THE DEVELOPMENT IN CANADA OF SCIENTIFIC RESEARCH, PRESENTED TO THE HOUSE OF COMMONS ON APRIL 27, 1920.

The Special Committee appointed last year to consider the above question presented their report thereon to this House on the 2nd day of July, 1919. In that report the establishment of a Bureau of Standards was recommended, but while a generous national support for scientific research was unanimously favoured, for the reasons then stated no decision was reached as to the precise method whereby that support could be most effectively applied.

Your committee, the majority of whom served in a similar capacity last year, having further considered the whole matter in the light of the evidence and material already adduced have no hesitation in stating that the urgency of action to be taken to establish a National Research Institute to promote scientific and industrial research in Canada is patent to all who know what is being done abroad in this line.

There is in Canada no organization which even distantly approaches the character of any of the Research Institutes abroad or now being established.

Great Britain has the National Physical Laboratory at Teddington, near London. Germany has two Research Institutes, one Physical and the other Chemical. In France and Italy measures are being taken to organize Research

Institutes. The United States has a National Bureau of Standards at Washington, to which is now attached a laboratory building of exceedingly ample accommodation to be devoted to industrial research. The amount spent by the bureau exceeds two million dollars a year. The Commonwealth Government of Australia is establishing an Institute of Science and Industry. An Institute for Research known as the Cawthorn Institute is being established at Nelson, New Zealand, by private benefaction. Japan is founding a National Research Institute, for which already ample funds have been obtained from the Emperor, the Government and from private sources.

It is evident, therefore, that Canada, to meet the international competition which the work of these laboratories will serve to accentuate very greatly, must have a National Research Institute, which will place at the command of the country all the resources of science and further the development of the natural wealth of the country to meet the huge burden of debt imposed by the war. The developed wealth of Canada as compared with that of the United States is small. If the natural resources of the Dominion were appropriately utilized, its developed wealth might readily be as much as ten times what it is now. The conversion of our natural resources into developed wealth, however, can only be accomplished through the application to them of science of the most highly advanced type.

To take one instance only, to show how vital research is to Canada, it may be pointed out that the high grade iron ores of the world are being exhausted, and, in consequence, the lower grades must in the very near future be alone available. Of these Canada has an enormous supply in areas distributed from the Atlantic to the Pacific. We are to-day importing annually at least $150,000,000 worth of ore, iron, steel and their products. If research could show us how to utilize commercially our own low grade iron ores in competition with foreign high grade ores we would not only build up important mining and manufacturing industries throughout Canada, but as well avoid remitting vast sums abroad.

It may be pointed out also, that in Great Britain the industrial firms in a large number of lines of industry are now being organized under the auspices of the Department of Scientific and Industrial Research into Trade Associations for Research. These industries will thereby be put in a position of enormous advantage as regards production. The National Research Council of the United States is organizing similar associations in the United States to meet competition from abroad. In Canada the organization of similar bodies, "Guilds for Research," must be encouraged by being associated with a National Research Institute.

Your committee believe the first step towards providing for the research required is the establishment of a National Research Institute whose functions will be to carry on researches, not only parallel to those of the Bureau of Standards at Washington, but such also as will assist in the development of the natural resources of the country and will promote the application of the most advanced scientific knowledge to all lines of industrial production in Canada.

In this connection your committee have considered the following matters:—

1. The scope of the work of the proposed Research Institute and the form of its government.
2. The site of the Institute and the character of the buildings which should first be erected.
3. The appropriation that should be made by Parliament during this session for the purchase of a site. The erection of the buildings and the maintenance of the Institute.

1. The work of the Institute should include the following:—

(*a*) The investigation and determination of standards and methods of measurements including length, volume, weight, mass, capacity, time and heat, light, electricity, magnetism and other forms of energy; and the determination of physical constants and the fundamental properties of matter.

(*b*) The standardization of the scientific and technical apparatus and instruments for government service and for use in the industries of Canada; and the determination of the standards of quality of the materials used in the construction of public works and of the supplies used in the various branches of the Government service.

(*c*) The investigation and standardization upon request of the materials which are or may be used in the industries, and of the products thereof.

(*d*) Researches undertaken with the object of improving the technical processes and methods used in the industries and of discovering new processes and methods which may promote the expansion of the existing industries or the development of new Canadian industries.

(*e*) Researches undertaken to assist in the development of the natural resources of Canada.

(*f*) Researches undertaken to promote the utilization of the waste products of industries.

2. The Institute should have charge, direction or supervision under conditions to be determined in each case of the researches which may be undertaken by or for individuals or industrial firms or by such organizations, to be known as Trade Guilds for Research, as may desire to avail themselves of the facilities offered for this purpose by the Institute.

Your committee strongly recommend:—

1. That a National Research Institute for Canada endowed with the functions and of the character indicated in the foregoing be established in the vicinity of Ottawa, on a site fifty acres in area, of easy access and conveniently located for water, gas and electric power supply.

2. That the first building to be erected for the Institute should be of the best modern construction suitable for laboratory work and of such dimensions as to provide accommodation for some years to come.

3. That there be appropriated by Parliament $500,000 for the purchase of the site and the construction of the building, $100,000 for the scientific equipment of the Institute, and $50,000 for salaries and maintenance during the first year of its operation.

4. That legislation be enacted at this session to provide for the establishment of this National Research Institute and the government of the same.

APPENDIX J

LIST OF FELLOWSHIPS, STUDENTSHIPS AND BURSARIES, 1921-22

FELLOWSHIPS

Name	Where held	Subject of Research
Miss C. W. Frits, B.A., M.Sc., (McGill).	Department of Botany, University of Toronto.	Continuation of Research on the determination of cultural criteria for the identification of wood-destroying fungi.
H. J. C. Ireton, B.A., M.A. (Toronto).	Department of Physics, University of Toronto.	Piezo-Electricity and its application to the measurement of explosive pressures.
J.W. McKinney, B.Sc. (Univ. of Alta.), M.Sc. (McGill).	Department of Chemistry, McGill University.	The kerogen in oil shale.
T. C. McMullen, B.A., M.A. (Toronto).	Department of Chemistry, University of Toronto.	Friedel and Craft's reaction: A study of the intermediate compounds obtained in the reaction between phthalic anhydrides, aluminium chloride and various aromatic hydrocarbons.
W. W. Shaver, B.A., M.A. (Toronto).	Department of Physics, University of Toronto.	A test of the modern theory of extra-nuclear electronic configuration.
C. A. H. Wright, B.Sc., M.Sc. (Univ. of B.C.), Ph.D. (McGill).	Department of Chemistry, University College, University of London.	Investigation of an aspect of the physical chemistry of coloured glasses; a study of borax glasses containing gold and copper.
J. F. T. Young, B.A., M.A. (Toronto).	Department of Physics, University of Toronto.	Continuation of investigation on the X-ray structure of magnetic alloys.

STUDENTSHIPS

Name	Where held	Subject of Research
E. H. Boomer, B.Sc. (Univ. of B.C.), M.Sc. (McGill).	Department of Chemistry, McGill University.	An investigation of the forces of molecular attraction on various substances in the gaseous condition.
C. Greaves, B.Sc., M.Sc. (McGill).	Department of Chemistry, McGill University.	The preparation and properties of metallic beryllium.
G. H. W. Lucas, B.A., M.A. (Toronto).	Department of Chemistry, University of Toronto.	Investigation to isolate by chemical means the growth promoting factor in yeast.
W. C. McQuarrie, B.A., M.A. (Toronto).	Department of Physics, University of Toronto.	An investigation of forked X-ray tracks in helium and hydrogen.
H. G. Oddy, B.A., M.A. McMaster), M.A. (Toronto.)	Department of Organic Chemistry, University of Toronto.	A study of the products obtained when maleic acid is treated according to Friedel and Craft's reaction with aluminium chloride and different cyclic hydrocarbons.
D. A. Scott, B.A. (Toronto)	Department of Chemistry, Queen's University.	The action of calcium bisulphite on dextrose.
G. M. Shrum, B.A., M.A. (Toronto).	Department of Physics, University of Toronto.	Liquefaction of hydrogen and helium.
H. N. Stephens, B.A. (McMaster), M.A. (Toronto).	Department of Chemistry, McGill University.	The constitution of caoutchouc.
Miss M. Anderson, B.A. (Univ. of N.B.), M.Sc. (McGill).	Department of Bacteriology, University of Toronto.	Resigned.
A. G. Dustan, B.Sc.A.....	Macdonald College	Award deferred.
A. H. Leim, B.A. (Toronto)	University of Toronto	Award deferred.
C. A. Mackay, B.A., M.A (Dalhousie).	Department of Physics, University of Toronto.	Resigned.
P. A. Petrie, B.A. (Toronto).	Department of Physics, University of Toronto	Resigned.
W. W. E. Ross, B.A. (Toronto).	University of Toronto.....	Resigned.

BURSARIES

Name	Where held	Subject of Research
F. B. Adamstone, B.A., M.A. (Toronto).	Department of Biology, University of Toronto.	Economic importance of the Molluscs in lake waters of Ontario (with special reference to Lake Nipigon).
Miss F. M. Cale, B.A., M.A. (Toronto).	Department of Physics, University of Toronto.	A study of the radiations emitted by atoms of various elements when such atoms are made to absorb certain selected monochromatic vibrations
Miss M. L. Clark, B.A., M.A. (Toronto).	Department of Physics, University of Toronto.	A study of the nature of the gases in the potassium bearing minerals, such as sylvyn, the feldspars, etc., with a view to learning whether argon and helium are occluded and whether these gases are present in proportionate amounts.

LIST OF FELLOWSHIPS, ETC.—*Concluded*

BURSARIES—*Con.*

Name	Where held	Subject of Research
Miss A. E. Dempsey, B.A. (McMaster).	Department of Biochemistry, University of Toronto).	To observe the rate of formation of peptones in protein hydrolysis with the special object of determining at what stage these possess the maximum shock-producing effect.
E. P. Dolan, B.Sc., M.A. (St. Francis Xavier).	Department of Geology, McGill University.	No problem assigned.
V. H. Emory, B.A.Sc. (Toronto).	Department of Zymology, University of Toronto.	A study of protein decomposition by acetone, butyl alcohol bacteria.
T. S. C. Fawcett, B.A.Sc., M.A.Sc. (Toronto).	Department of Mining Engineering, University of Toronto.	A study of the variables in ball milling and their effect on efficiency.
R. E. Foerster, B.A., M.A. (Univ. of B.C.).	Department of Zoology, University of British Columbia.	A systematic study of the medusae of the Vancouver island region and the development of some of the species.
J. C. Forbes, B.A., M.A. (Univ. of Sask.).	Department of Chemistry, University of Saskatchewan.	The solubilities of some of the constituents of Portland cement in salt solutions.
Miss M. A. Frits, B.A. (McGill).	Department of Geology, University of Toronto.	Examination of some of the local strata in the immediate vicinity of Toronto for the purpose of classification of the fossil organisms.
Miss K. F. Godwin, B.A. (McGill).	Department of Botany, McGill University.	The causes and prevention of the deterioration of ground-wood pulp.
R. H. Harris, B.A. (Univ. of Sask.).	Department of Chemistry, University of Saskatchewan.	The changes in the composition of concrete and cement during the action of alkaline solutions.
Miss E. W. Hill, B.A., M.S (McGill).	Department of Chemistry, McGill University.	The autohydrolysis of fats.
W. V. Howard, B.A., M.Sc. (McGill).	Department of Geology, McGill University.	Some outliers of the Mesteregian Hills.
Miss M. Levi, B.A., M.A. (Toronto).	Department of Physics, University of Toronto.	An investigation of the photo-electric sensitivity of the diamond, to be followed up by investigating that of various phosphorescent liquids and crystals.
D. J. MacLeod, B.A. (Queen's).	Bacteriological Laboratory, Queen's University.	The action of the hydrogen-ion on the mobility of bacteria.
W. H. McCurdy, B.A. (Dalhousie).	Department of Physics, Dalhousie University.	An investigation of the effect of dust and moisture on the conductivity and di-electric strength of transformer oils; also the effect of temperature.
John Melville, B.A.Sc. (Univ. of B.C.).	Department of Chemistry, University of British Columbia.	The vapour pressure of carbon dioxide in equilibrium with mixtures of solutions of potassium carbonate and potassium bicarbonate.
Miss M. E. M. Olding, B.A. (McGill).	Inorganic Laboratory, Department of Chemistry, McGill University.	The solubility of ferrous ammonium sulphate in aqueous sulphuric acid.
J. F. Phillips, B.A.Sc. (Toronto).	Department of Zymology, University of Toronto.	The nature and method of formation of intermediate compounds in the fermentation of carbohydrates by bacillus aceto-ethylicum.
H. N. Racicot, B.A. (McMaster).	Department of Botany, University of Toronto.	The relation of the injury of the crown of a plant to the health of the roots.
Miss J. D. Spier, B.A., M.Sc (McGill).	Botanical Laboratory, McGill University.	Causes and prevention of the decay of chemical pulps.
H. G. Smith, B.A., M.A. (Toronto).	Department of Physics, University of Toronto.	The indices of refraction and dispersion of metallic vapours.
Miss E. M. Taylor, B.A., M.A. (Toronto).	Department of Chemistry, University of Toronto.	The effect of different acids on the growth of yeast.
Miss M. Weinberg, B.A., M.A. (Univ. of Man.).	Department of Physics, University of Manitoba.	The function of resonance as a part of the physical theory of audition; a study in experimental acoustics.
D. Wolochow, B.A., M.A. (Univ. of Sask.).	Department of Chemistry, University of Saskatchewan.	The effect of alkali and related substances on cement, including an investigation of the behaviour of silicates in water and in presence of various concentrations of different salts.
Miss D. E. Newton, B.S.A., M.Sc. (McGill).	Department of Bacteriology, Macdonald College.	Marine spore-forming bacteria with the object of isolating from marine sources a number of spore-forming organisms, ascertaining their life history, identifying them, and finding out their thermal death points.
Miss J. D. Dart, B.A. (McGill).	McGill University.....	Resigned.
F. Ferguson, B.A. (St. Francis Xavier).	.....	Died.
W. E. Green, B.A. (Toronto).	.....	Resigned.
Miss M. H. Higginson, B.A. (McGill).	McGill University.....	Resigned.
Miss J. V. Lane, B.A. (Toronto).	University of Toronto.....	Resigned.
J. L. McDonald, B.A. (St. Francis Xavier).	Department of Biochemistry, University of Toronto	Resigned.
D. M. Morrison, B.Sc (Univ. of B.C.), M.Sc. (McGill).	Department of Chemistry, University of British Columbia.	Resigned.
L. W. Rentner, B.A. (Toronto).	Department of Physics, University of Toronto	Resigned.

APPENDIX K

LIST OF ASSISTED RESEARCHES, 1921-22

Grantee	Where carried on	Subject of Research	Amount awarded
			$
Prof. Wilfrid Sadler	Department of Dairying, Univ. of British Columbia, Vancouver, B.C.	To complete investigation to determine the character of the bacteria and other germs which are found in cream, milk and butter.	400 00
Prof. John Davidson	Botanical Gardens, University of British Columbia, Vancouver, B.C.	An investigation of certain economic flora of British Columbia.	850 00
Louis Simpson, Esq., Ottawa, Ont.	Quebec and New Brunswick	To purchase a field laboratory for the preliminary testing of oil shales.	300 00
Prof. J. C. McLennan	Department of Physics, University of Toronto, Toronto, Ont.	Investigation regarding the relations of the infra-red rays of the spectrum to the structure of atoms.	1,500 00
Prof. A. L. Hughes	Department of Physics, Queen's University, Kingston, Ont.	To purchase a specially designed motor generator set for giving up to 1,500 volts with a current up to 0·2 amperes with necessary accessories.	500 00
Dr. F. C. Harrison	Macdonald College	Investigation into the cause and treatment of acidity in the soils in the provinces of Quebec and New Brunswick.	2,000 00
Prof. H. E. T. Haultain	Department of Mining Engineering, University of Toronto, Toronto, Ont.	To purchase special apparatus to be used in his study of the action of ball mills.	400 00
Associate Committee on the Nutritional Problems of the Fox industry.	Experimental Station, Dept of Agriculture, Hull, Que.	To continue the investigation of the problems affecting the fox industry of Canada.	6,800 00
Associate Food Research Committee.	Laboratory of Food Chemistry, University of Toronto, Ont.	To continue investigation on vitamines	1,250 00
Committee of the Engineering Institute of Canada.	University of Saskatchewan, Saskatoon, Sask.	Investigation of the causes of the deterioration of concrete in the provinces of Manitoba, Saskatchewan and Alberta, through action of alkali waters of the soils.	5,000 00
Prof. J. W. Shipley	Department of Chemistry, University of Manitoba, Winnipeg, Man.	Investigation of the causes of soil corrosion of iron piping.	1,700 00
Prof. H. F. Roberts	Department of Botany, University of Manitoba, Winnipeg, Man.	Investigation of the inheritance of sugar and starch in the endosperm of different varieties of Indian corn.	250 00

APPENDIX L

PUBLICATIONS OF THE HONORARY ADVISORY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH OF CANADA

ANNUAL REPORTS FOR THE YEARS 1917-18, 1918-19, 1919-20, 1920-21

GENERAL REPORTS

1. The Briquetting of Lignites by R. A. Ross, E.E., D.Sc.
2. The Recovery of vapours from Gases by Harold S. Davis, M.A.; Ph.D., Davis, B.A.
3. The De-tarring of Gas by Electrical Precipitation by J. G. Davidson, Ph.D.
4. Nicotine and Tobacco Waste by A. D. Hone, M.A.
5. Canadian Waste Sulphite Liquor as a Source of Alcohol by Vernon K. Krieble, Ph. D.
6. An Investigation into the Question of early Putrefaction of Eviscerated Fish in which the Gills have been left by Louis Gross, M.D.
7. Survey of General Conditions of Industrial Hygiene in Toronto by Associate Committee on Industrial Fatigue of the Research Council.
8. A Method of Smelting Titaniferous Iron Ore by W. M. Goodwin, B.A. B.Sc.
9. Food Requirements of the Ranch Fox by G. Ennis Smith, B.A.Sc.
10. Fuel Saving Possibilities in House Heating by L. M. Arkley, M.Sc., and James Govan.
11. Red Discoloration of Cured Codfish by F. C. Harrison, D.Sc., and Miss Margaret E. Kennedy, B.A., M.Sc.
12. The Discoloration, Smut or Blackening of Canned Lobster by F. C. Harrison, D.Sc., and E. G. Hood, Ph.D.

BULLETINS

1. The Need for Industrial Research in Canada by Frank D. Adams, Sc.D., LL.D. F.R.S.
2. Researches on Sound Measurement by Louis V. King, M.A., D.Sc., F.R.S.C.
3. How to Handle Frozen Fish by E. E. Prince, D.Sc., LL.D.
4. Hints on Frozen Fish by E. E. Prince, D.Sc., LL.D.
5. Science and Industry by Prof. J. C. Fields, Ph.D., F.R.S.
6. The Heating of Houses, Coal and Electricity Compared by A. S. L. Barnes.
7. The Manufacture of Ethyl Alcohol from Wood Waste by G. H. Tomlinson, B.A.
8. Some Problems of the Fox-Raising Industry by Andrew Hunter, M.A., B.Sc., M.B., Ch.B. (Edin.)
9. The Honorary Advisory Council of Scientific and Industrial Research and its work by Frank D. Adams, Sc.D., LL.D., F.R.S.
10. A Plan for the Development of Industrial Research in Canada by R. F. Ruttan, B.A., M.D., D.Sc., F.R.S.C.

REPORT

OF THE

ADMINISTRATIVE CHAIRMAN

OF THE

HONORARY ADVISORY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH OF CANADA

For the Year ending March 31, 1922

OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1923

OTTAWA, January 15, 1923.

The Honourable JAMES A. ROBB,
Chairman of the Sub-Committee of the Privy Council
for Scientific and Industrial Research,
Ottawa, Ont.

SIR,—I have the honour of presenting to you herewith the report on the work of the Honorary Advisory Council for Scientific and Industrial Research for the year ending March 31, 1922.

Your obedient servant,

FRANK D. ADAMS,
Administrative Chairman of the Honorary Advisory Council for Scientific and Industrial Research.

TABLE OF CONTENTS

PAGE

The Sub-Committee of the Privy Council for Scientific and Industrial Research.. ..

The Honorary Advisory Council for Scientific and Industrial Research.. .. ..

The Associate Committee of Chemists.. 6

The Associate Committee on Mining and Metallurgy.. 7

The Associate Committee on Physics and Engineering Physics.. 8

The Associate Air Research Committee.. 9

The Associate Committee on Flax.. 10

The Associate Food Research Committee.. 10

The Associate Biological Committee.. 11

The Associate Committee on Industrial Fatigue.. 11

The British Columbia Advisory Committee.. 12

The Associate Committee on the Nutritional Problems of the Fox Industry.. 13

The Special Canadian Committee on Pacific Investigations.. 13

The Report of the Administrative Chairman of the Research Council of Canada:

Section I. General Account of the Work of the Council.. 15

Section II. Training of Research Workers 15

Section III. Assisted Researches.. 16

Section IV. The Standing Associate Committee.. 20

Section V. Administration and Finance.. 24

Section VI. The National Research Institute.. 25

APPENDICES

A. Report of the Associate Committee on Mining and Metallurgy.. 28

B. Report of the Associate Committee on Physics and Engineering Physics.. 29

C. Report of the Associate Committee on the Nutritional Problems of the Fox Industry.. 32

D. Report of the Associate Food Research Committee.. 34

E. Report of the Associate Air Research Committee.. 36

F. Report of the Special Committee on Nitrogen Fixation.. 38

G. Report of the Meeting of the International Research Council, held in Brussels in July, 1922.. 40

H. Progress Report of the Lignite Utilization Board of Canada.. 42

I. Report of the Committee of the House of Commons, Appointed to Consider the Matter of the Development in Canada of Scientific Research.. 44

J. List of Fellowships, Studentships and Bursaries.. 47

K. List of Assisted Researches.. 49

L. Publications of the Honorary Advisory Council for Scientific and Industrial Research of Canada.. 50

THE SUB-COMMITTEE OF THE PRIVY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

The Honourable JAMES A. ROBB, *Minister of Trade and Commerce, Chairman.*

The Honourable CHARLES STEWART, *Minister of the Interior and of Mines.*

The Honourable WILLIAM R. MOTHERWELL, *Minister of Agriculture.*

The Honourable JACQUES BUREAU, LL.B., *Minister of Customs and Inland Revenue.*

The Honourable JAMES MURDOCK, *Minister of Labour.*

THE HONORARY ADVISORY COUNCIL

Administrative Chairman: FRANK D. ADAMS, Sc.D., LL.D., F.R.S., Hon. M.E.I.C. Hon. M.I.M.M., Hon. M.A.I.M.M.E., Dean, Faculty of Applied Science, McGill University, Montreal, Que.

Secretary: S. P. EAGLESON, Esq., Ottawa, Ont.

Members:

HUME CRONYN, B.A., LL.B., London, Ont.

Sir GEORGE GARNEAU, B.A.Sc., LL.D., 2 Cook St., Quebec, Que.

W. L. GOODWIN, D.Sc., LL.D., F.R.S.C., Emeritus Professor of Chemistry, Queen's University, Kingston, Ont.

A. B. MACALLUM, Ph.D., Sc.D., LL.D., F.R.S., Professor of Biochemistry, McGill University, Montreal, Que.

A. S. MACKENZIE, Ph.D., D.C.L., LL.D., F.R.S.C., President, Dalhousie University, Halifax, N.S.

J. C. MCLENNAN, O.B.E., Ph.D., D.Sc., LL.D., F.R.S., Professor of Physics and Director of the Physics Laboratory, University of Toronto, Toronto, Ont.

W. C. MURRAY, M.A., LL.D., F.R.S.C., President, University of Saskatchewan, Saskatoon, Sask.

R. F. RUTTAN, B.A., M.D., D.Sc., F.R.S.C., Professor of Chemistry and Director of the Chemical Laboratories, McGill University, Montreal, Que.

ARTHUR SURVEYER, B.A.Sc., M.E.I.C., Consulting Engineer, Room 715, 145 St. James St., Montreal, Que.

H. M. TORY, M.A., D.Sc., LL.D., F.R.S.C., F.R.H.S., President, University of Alberta, Edmonton, Alta.

52615—2½

MEMBERS OF THE ASSOCIATE COMMITTEE OF CHEMISTS

R. F. Ruttan, B.A., M.D., D.Sc., F.R.S.C., Chairman	Director, Department of Chemistry, McGill University, Montreal, Que.
Frank D. Adams, Sc.D., LL.D., F.R.S., Hon. M.E.I.C.	Chairman, Research Council of Canada. (Ex-officio).
H. E. Bigelow, Ph.D.	Prof. of Chemistry, Mount Allison University, Sackville, N.B.
F. J. Birchard, B.A., Ph.D.	Research Chemist, Dominion Grain Laboratory, Winnipeg, Man.
M. C. Boswell, B.A.Sc., Ph.D.	Research Chemist, Dominion Grain Laboratory, Winnipeg, Man.
Alfred Burton, Esq.	Middlesex Mills, London, Ont.
T. Linsey Crossley, A.M.E.I.C.	43 Scott St., Toronto, Ont.
J. R. Donald, B.A., B.Sc., A.M.E.I.C.	J. T. Donald & Co., 40-42 Belmont St., Montreal, Que.
Horace Freeman, F.C.I.C.	567 Hornby St., Vancouver.
R. E. Gilmore, M.A., M.Sc.	Chief Chemist, Standard Chemical Iron and Lumber Co., Montreal, Que.
Fred J. Hambly, F.I.C.	Electrical Reduction Co., Buckingham, Que.
Robert Job, B.A.	Milton Hersey Co., Ltd., 84 St. Antoine St., Montreal, Que.
Paul Cardinaux, D.Sc.	Professor of Inorganic Chemistry, Laval University, Quebec City, Que.
Neil Macallum, M.A., Ph.D.	Synthetic Drug Co., Toronto.
A. E. Macintyre, Ph.D.	Explosives Division, Dept. of Mines, Ottawa, Ont.
A. Nieghorn, Esq.	Mgr. Nichols Chem. Co., 20 Douglas Drive, Toronto, Ont.
Arthur C. Neish, M.A., Ph.D.	Director, Dept. of Chemistry, Queen's University, Kingston, Ont.
J. W. Shipley, M.A., Ph.D.	Dept. of Chemistry, University of Manitoba, Winnipeg, Man.
T. Thorvaldson, B.A., Ph.D.	Professor of Chemistry, University of Saskatchewan, Saskatoon, Sask.
Geo. H. Tomlinson, B.A.	The Riordon Co., Ltd., Hawkesbury, Ont.
Harold van der Linde, Ph.D.	Pres. van der Linde Rubber Co., 142 Weston Rd., Toronto, Ont.
R. A. Witherspoon, M.A.	Manager, Carbide Works, Shawinigan, Que.

MEMBERS OF THE ASSOCIATE COMMITTEE ON MINING AND METALLURGY, 1920-21

Frank D. Adams, Sc.D., LL.D., F.R.S., Hon. M.E.I.C., Chairman	Dean, Faculty of Applied Science, McGill University, Montreal, Que.
A. A. Cole, B.Sc., M.A.	Mining Engineer, Temiskaming & Northern Ontario Railway Commission, Cobalt, Ont.
C. V. Corless, M.Sc., LL.D., M.E.I.C.	General Manager, Mond Nickel Co., Coniston, Ont.
T. C. Denis, B.Sc.	Dept. of Colonization, Mines and Fisheries, Quebec, Que.
Chas. Fergie, Esq.	Pres. Intercolonial Coal & Coke Co., 413 Dominion Express Bldg., Montreal, Que.
George A. Guess, M.A.	Prof. of Metallurgy, University of Toronto, Toronto, Ont.
H. E. T. Haultain, C.E., M.I.M.M., M.E.I.C.	Prof. of Mining Engineering, University of Toronto, Toronto, Ont.
A. Mailhiot, B.Ap.Sc.	Prof. of Geology, University of Montreal, 228 St. Denis St., Montreal, Que.
D. H. McDougall, LL.D., M.E.I.C.	Pres. Nova Scotia Steel & Coal Co., Ltd., New Glasgow, N.S.
J. G. Morrow, Esq.	Inspecting Engineer, Steel Company of Canada, Hamilton, Ont.
J. B. Porter, E.M., Ph.D., Sc.D., M. Inst. C.E., M.E.I.C.	Professor of Mining Engineering, McGill University, Montreal, Que.
Fraser D. Reid, B.Sc., M.E.I.C.	Manager, Coniagas Mines, Ltd., Cobalt, Ont.
W. Fleet Robertson, B.Sc.	Provincial Mineralogist, Dept. of Mines, Victoria, B.C.
F. H. Sexton, D.Sc.	Pres. Nova Scotia Technical College, Halifax, N.S.
A. Stansfield, Sc.D., A.R.S.M., F.R.S.C., M.E.I.C.	Prof. of Metallurgy, McGill University, Montreal, Que.
John T. Stirling, Esq.	Chief Inspector of Mines for Alberta, Dept. of Public Works, Edmonton, Alta.
R. H. Stewart, B.Sc.	Consulting Mining Engineer, 736 Granville St., Vancouver, B.C.
J. B. Tyrrell, B.Sc., M.A., M.I.M.M., F.R.S.C.	Consulting Mining Engineer and Geologist, 534 Confederation Life Bldg., Toronto, Ont.
O. E. S. Whiteside, M.Sc.	General Manager, International Coal & Coke Co., Coleman, Alta.

ASSOCIATE COMMITTEE ON PHYSICS AND ENGINEERING PHYSICS

J. C. McLennan, O.B.E., Ph.D., LL.D., F.R.S., Chairman	Prof. of Physics and Director of the Physics Laboratory, University of Toronto, Toronto, Ont.
Frank D. Adams, Sc.D., LL.D., F.R.S., Hon. M.E.I.C.	Chairman, Research Council of Canada. (Ex-officio).
John Patterson, M.A., F.R.S.C., Secretary	Physicist, Meteorological Office, Toronto, Ont.
Frank Allen, M.A., Ph.D., F.R.S.C.	Professor of Physics, University of Manitoba, Winnipeg, Man.
R. W. Boyle, M.A., Ph.D.	Prof. of Physics, University of Alberta, Edmonton, Alta.
Louis Bourgoin, I.Ch.	Prof. of Physics, University of Montreal, 228 St. Denis St., Montreal, Que.
H. L. Bronson, B.A., Ph.D., F.R.S.C.	Professor of Physics, Dalhousie University, Halifax, N.S.
A. L. Clark, B.S.C., Ph.D., F.R.S.C., A.E.I.C.	Professor of Physics, Queen's University, Kingston, Ont.
W. P. Dobson, M.A.Sc., M.E.I.C.	Hydro-Electric Research Laboratories, 8 Strachan Ave., Toronto, Ont.
A. S. Eve, C.B.E., M.A., D.Sc., F.R.S.C., F.R.S.	Director, Physics Department, McGill University, Montreal, Que.
L. A. Herdt, E.E., D.Sc., F.R.S.C., M.E.I.C.	Prof. of Electrical Engineering, McGill University, Montreal, Que.
H. O. Keay, B.Sc. (Mass. Inst. of Tech.) M.E.I.C.	Consulting Engineer, Laurentide Pulp and Paper Co., Grand Mere, Que.
A. G. McGougan, B.A., Ph.D.	Prof. of Physics, University of Saskatchewan, Saskatoon, Sask.
J. S. Plaskett, B.A., D.Sc., F.R.S.C.	Director, Astrophysical Laboratory, Victoria, B.C.
T. R. Rosebrugh, M.A.	Prof. of Electrical Engineering, University of Toronto, Toronto, Ont.
LW. Gill, M.Sc., M.E.I.C.	Prof. of Electrical and Mechanical Engineering, University of British Columbia, Vancouver, B.C.

ASSOCIATE AIR RESEARCH COMMITTEE

A. S. Eve, C.B.E., M.A., D.Sc., F.R.S.C., Chairman	Director, Dept. of Physics, McGill University, Montreal, Que.
Frank D. Adams, Sc.D., LL.D., F.R.S., Hon. M.E.I.C.	Chairman, Research Council of Canada. (Ex-officio).
R. J. Durley, M. Inst. C.E., M.E.I.C., M.Am. Soc. M.E.	Secretary, Canadian Engineering Standards Association, West Block, Ottawa, Ont.
J. C. McLennan, O.B.E., Ph.D., Sc.D., LL.D., F.R.S.	Professor of Physics and Director of Physics Laboratory, University of Toronto, Toronto, Ont.
J. H. Parkin, B.A.Sc., M.E.	Asst. Professor of Mechanical Engineering, University of Toronto, Toronto, Ont.
Lt.-Col. E. W. Stedman, O.B.E., M.E.I.C.	Wing Commander, Canadian Air Force, Canadian Bldg., Ottawa, Ont.
Commander C. P. Edwards, R.N.C.V.R., A.M.E.I.C.	General Superintendent, Radio Telegraph Service, Department of Naval Service, Ottawa, Ont.

THE FOLLOWING ARE ASSOCIATE MEMBERS OF THIS COMMITTEE

C. Batho, D.Sc., A.M.E.I.C.	Assoc. Prof. of Applied Mechanics and Mathematics, McGill University, Montreal, Que.
R. W. Boyle, M.A., Ph.D.	Prof. of Physics, University of Alberta, Edmonton, Alta.
E. Deville, LL.D., D.T.S., F.R.S.C.	Surveyor General, Department of the Interior, Ottawa, Ont.
Capt. R. J. Grant	84 Charles St., W., Toronto, Ont.
Louis V. King, M.A., D.Sc., F.R.S.C.	Prof. of Physics, McGill University, Montreal, Que.
C. M. McKergow, M.Sc., M.E.I.C.	Prof. of Mechanical Engineering, McGill University, Montreal, Que.
John Patterson, M.A., F.R.S.C.	Physicist, Meteorological Office, Toronto, Ont.
J. B. Porter, E.M., Ph.D., Sc.D., M. Inst. C.E., M.E.I.C.	Prof. of Mining Engineering, McGill University, Montreal, Que.
C. A. Robb, B.Sc., M.Sc., A.M.E.I.C.	Prof. of Mechanical Engineering, University of Alberta, Edmonton, Alta.
Stanley Smith, M.A., B.Sc.	Lecturer in Physics, University of Alberta, Edmonton, Alta.
Sir Fredrick Stupart, F.R.S.C.	Superintendent and Director, Meteorological Service, Toronto, Ont.
W. R. Turnbull, M.E., F.R. Ae. S., F.R. Met. S.	Consulting Engineer, Rothesay, N.B.

ASSOCIATE COMMITTEE ON FLAX

R. F. Ruttan, B.A., M.D., Sc.D., F.R.S.C.	Professor of Chemistry and Director of the Chemical Laboratories, McGill University, Montreal, Que.
Frank D. Adams, Sc.D., LL.D., F.R.S., Hon. M.E.I.C.	Chairman, Research Council of Canada. (Ex-officio).
F. VanBruyssel, Esq.	Beaupre, Montmorency Co., Que.
J. H. Grisdale, D.S.A., B.Agr.	Deputy Minister, Department of Agriculture, Ottawa, Ont.
W. C. Murray, M.A., LL.D.	President, University of Saskatchewan, Saskatoon, Sask.

ASSOCIATE FOOD RESEARCH COMMITTEE

A. B. Macallum, M.A., M.B., Ph.D., Sc.D., LL.D., F.R.S.	Professor of Biochemistry, McGill University, Montreal, Que.
Frank D. Adams, Sc.D., LL.D., F.R.S., Hon. M.E.I.C.	Chairman, Research Council of Canada. (Ex-officio).
Clara C. Benson, Ph.D.	Dept. of Food Chemistry, University of Toronto, Toronto, Ont.
A. T. Cameron, M.A., B.Sc.	Dept. of Biochemistry, University of Manitoba, Winnipeg, Man.
A. Bruce Macallum, M.A., M.D., Ph.D.	243 College St., Toronto, Ont.

ASSOCIATE BIOLOGICAL COMMITTEE

A. B. Macallum, Ph.D., Sc.D., LL.D., F.R.S., Chairman	Professor of Biochemistry, McGill University, Montreal, Que.
Frank D. Adams, Sc.D., LL.D., F.R.S., Hon. M.E.I.C.	Chairman, Research Council of Canada. (Ex-officio).
L. W. Bailey, M.A., Ph.D., LL.D., F.R.S.C.	Emeritus Prof. of Natural History, and Geology, Fredericton, N.B.
A. H. R. Buller, D.Sc., Ph.D., F.R.S.C.	Professor of Botany, University of Manitoba, Winnipeg, Man.
F. C. Harrison, B.S.A., D.Sc., F.R.S.C.	Principal, Macdonald College, Ste. Anne de Bellevue, Que.
Canon V. A. Huard, D.Sc., F.R.S.C.	2 Richelieu St., Quebec, Que.
Andrew Hunter, B.Sc., M.B., M.A., Ch.B., F.R.S.C.	Professor of Biochemistry, University of Toronto, Toronto, Ont.
A. P. Knight, M.A., M.D., F.R.S.C.	Emeritus Professor of Physiology, Kingston, Ont.
A. H. Mackay, B.A., B.Sc., LL.D., F.R.S.C.	Superintendent of Education, Halifax, N.S.
J. J. R. Macleod, M.B., Ch.B., D.P.H., F.R.S.C.	Professor of Physiology, University of Toronto, Toronto, Ont.
W. T. MacClement, M.A., B.Sc.	Professor of Botany, Queen's University, Kingston, Ont.
J. P. McMurrich, M.A., Ph.D., LL.D., F.R.S.C.	Professor of Anatomy, University of Toronto, Toronto, Ont.
E. E. Prince, B.A., LL.D., F.R.S.C.	Dominion Commissioner of Fisheries, Dept. of Marine and Fisheries, Ottawa, Ont.

ASSOCIATE COMMITTEE ON INDUSTRIAL FATIGUE

J. J. R. Macleod, M.B., Ch.B., D.P.H., F.R.S.C., Chairman	Professor of Physiology, University of Toronto, Toronto, Ont.
Frank D. Adams, Sc.D., LL.D., F.R.S., Hon. M.E.I.C.	Chairman, Research Council of Canada. (Ex-officio).
E. A. Bott, M.A., Ph.D., Honorary Secretary.	Associate Prof. of Psychology, University of Toronto, Toronto, Ont.
Mrs. Geo. Hambleton, M.A.	511 Gilmour St., Ottawa, Ont.
John Lowe, Jr., Esq.	Representative of Canadian Manufacturers' Association, Montreal Cottons, Ltd., Valleyfield, Que.
A. B. Macallum, Ph.D., Sc.D., LL.D., F.R.S.	Professor of Biochemistry, McGill University, Montreal, Que.
J. A. McClelland, Esq.	Representative of Trades and Labour Congress, 113 Coronation Building, Montreal, Que.

THE BRITISH COLUMBIA ADVISORY COMMITTEE

J. M. Turnbull, B.A.Sc., Chairman	Professor of Mining and Metallurgy, and Head of the Department of Metallurgy, University of British Columbia, Vancouver, B.C.
Frank D. Adams, Sc.D., LL.D., F.R.S., Hon. M.E.I.C.	Chairman, Research Council of Canada. (Ex-officio).
Judson F. Clark, M.A., Ph.D.	Forest Engineer, 420-424 Vancouver Block, Vancouver, B.C.
C. McLean Fraser, M.A., Ph.D., F.R.S.C.	Curator, Biological Station, Nanaimo, B.C.
George Kidd, Esq.	General Manager, British Columbia Electric Railway Co., Hastings and Carrall Sts., Vancouver, B.C.
L. S. Klinck, M.S.A., D.Sc.	President, University of British Columbia, Vancouver, B.C.
H. R. MacMillan, B.S.A., M.F.	President, the H. R. MacMillan Timber Export Co., Vancouver, B.C.
P. H. Moore, B.S.A.	Superintendent, Colony Farm (B.C. Government Farm), Ensondale, B.C.
J. S. Raphael, B.Sc.	1236-13th Ave. W., Vancouver, B.C.
R. H. Stewart, B.Sc.	Consulting Mining Engineer, 736 Granville St., Vancouver, B.C.
Campbell Sweeny, Esq.	Vancouver, B.C.
James J. Warren, Esq.	Manager, Consolidated Mining and Smelting Co. of Canada, Trail, B.C.
Horace Freeman, F.C.I.C., Secretary	567 Hornby St., Vancouver, B.C.

THE FOLLOWING CONSTITUTE THE EXECUTIVE COMMITTEE OF THE BRITISH COLUMBIA ADVISORY COMMITTEE

Prof. J. M. Turnbull, B.A.Sc., Chairman	Professor of Mining and Metallurgy and Head of the Dept. of Metallurgy, University of British Columbia, Vancouver, B.C.
Horace Freeman, F.C.I.C., Secretary	567 Hornby Street, Vancouver, B.C.
C. McLean Fraser, M.A., Ph.D., F.R.S.C.	Curator, Biological Station, Nanaimo, B.C.
H. R. MacMillan, B.S.A., M.F.	President, the H. R. MacMillan Timber Export Co., Vancouver, B.C.

Google

ASSOCIATE COMMITTEE ON THE NUTRITIONAL PROBLEMS OF THE FOX INDUSTRY

Andrew Hunter, M.A., B.Sc., M.B., Ch.B., F.R.S.C., Chairman	Professor of Biochemistry, University of Toronto, Toronto, Ont.
Frank D. Adams, Sc.D., LL.D., F.R.S., Hon. M.E.I.C.	Chairman, Research Council of Canada. (Ex-officio).
V. J. Harding, D.Sc.	Professor of Pathological Chemistry, University of Toronto, Toronto, Ont.
C. Spencer Melvin, M.D.	Professor of Physiology, Queen's University, Kingston, Ont.
F. Torrance, B.A., D.V.Sc.	Veterinary Director-General, Department of Agriculture, Ottawa, Ont.
Arthur Vallée, M.D.	Professor of Pathological Anatomy, Laval University, Quebec, Que.
E. A. Watson, V.S.	Chief Animal Pathologist, Department of Agriculture, Ottawa, Ont.

SPECIAL CANADIAN COMMITTEE ON PACIFIC INVESTIGATIONS

J. P. McMurrich, M.A., Ph.D., LL.D., F.R.S.C., Chairman	University of Toronto	Biology.
C. McLean Fraser, M.A., Ph.D., F.R.S.C., Secretary	University of British Columbia	Biology.
Frank D. Adams, Sc.D., LL.D., F.R.S., Hon. M.E.I.C.	Chairman, Research Council of Canada (Ex-officio)	
R. W. Brock, M.A., LL.D., F.G.S., F.R.S.C.	University of British Columbia	Geology.
Chas. Camsell, B.Sc., LL.D.	Deputy Minister of Mines, Ottawa, Ont.	Geology.
Otto Klotz, LL.D., F.R.A.S.	Dominion Observatory, Ottawa, Ont.	Seismology and Allied Sciences.
J. S. Plaskett, B.A., D.Sc., F.R.S.C.	Dominion Astrophysical Observatory, Victoria, B.C.	Astronomy and Allied Sciences
Sir Frederick Stupart, F.R.S.C.	Meteorological Office, Toronto, Ont.	Meteorology and Allied Sciences.
Arthur Willey, M.A., D.Sc., F.R.S.	McGill University	Biology.

REPORT

OF THE

ADMINISTRATIVE CHAIRMAN

OF THE

HONORARY ADVISORY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

I. GENERAL ACCOUNT OF THE WORK OF THE COUNCIL

Eight meetings of the Council were held during the year, with an average attendance of seven members. Five of these meetings were held in Ottawa and three in Montreal.

The National Research Institute—which the Council considers to be a prime necessity for the further development of its work—not having been erected as yet, the Council has been obliged to confine its activities to those lines of work which it has followed during former years. It has in fact been obliged to "mark time" awaiting the establishment of a National Research Institute whose foundation will make possible new advances and the opening of further fields of investigation and research, for the benefit of Canadian industry and the development of the resources of the Dominion.

The work of the Research Council during the year under consideration may, therefore, be set forth under the following heads:—

(*a*) The training of research workers through the provision of Bursaries, Studentships and Fellowships.

(*b*) The investigation of a number of special problems by grants to investigators, known as "Assisted Researches."

(*c*) The encouragement and development of research by the organization of the research workers of Canada into Standing Associate Committees of the Research Council—and by the appointment of certain special committees to the same end. The scope of the work carried out under each of these heads will be described briefly.

II. TRAINING OF RESEARCH WORKERS

This work has been undertaken by the Research Council in order to develop in Canada a body of university graduates thoroughly trained in the methods of scientific investigation and research to the end that when research workers are required by Canadian industries, the Research Council or the Canadian universities, there will be men in the Dominion prepared and ready to fill the positions as they arise. This training is provided by the establishment of Bursaries, Studentships and Fellowships—each tenable for one year and having a value respectively of $750, $1,000, and $1,200. They are given only to men (or women) who have already graduated from a university and have shown distinct

aptitude for or ability in the field of scientific research. Ordinarily the successful candidate is first appointed to a Bursary, and if he proves to have the requisite capacity may be promoted to a Studentship in his second year, and in his third year may receive a Fellowship. These Bursaries, Studentships and Fellowships are tenable only at Canadian universities, except under certain very exceptional conditions, as for instance, when a man following some special line of research which cannot be carried out in Canada is allowed to study in Great Britain or in some foreign country.

There are each year many more applicants for these positions than there are Bursaries, etc., to be awarded, the successful candidates, therefore, represent an especially able group of young Canadians.

The following table shows the number of Bursaries, Studentships and Fellowships awarded annually during the last five years and the expenditure represented by these awards:—

Year	Fellowships	Studentships	Bursaries	Expenditure	Additional awards resigned		
					Fellowships	Studentships	Bursaries
				$ cts			
1917-18	3	4		5,550 00		2	
1918-19	3	5		7,150 00	1	4	
1919-20	5	16	5	20,100 00	1	3	
1920-21	5	10	8	16,925 00	3	3	
1921-22	7	9	30	37,725 00		3	
Totals	23	44	43	87,450 00			

The Council has decided to limit its annual expenditure under this head to a sum not exceeding $40,000, which represents the same proportion of the grant voted to the Council by the Dominion Government as is devoted to this purpose by the Research Council of Great Britain from the much larger grant made to it by the Imperial Parliament.

A list of the Bursaries, Studentships and Fellowships awarded during the present year will be found in appendix J of the present report. As will be seen the holders of these awards come from all parts of the Dominion and receive their advanced training in research chiefly in the larger universities of Canada, since in these alone is the requisite staff and equipment for advanced work in science provided.

It may be said in conclusion that these awards have already stimulated scientific research in Canada to a marked degree, and returns which have just been made to the Council show that the 123 persons who have held Bursaries, Studentships or Fellowships, with scarcely an exception, are now engaged in research in connection with industry or hold positions on the staff of our universities where their training enables them to carry on research in addition to their regular instructional work.

III. ASSISTED RESEARCHES

1. *Preservation of Concrete from the Destructive Action of Alkaline Waters.*—A few years ago the destructive effect on concrete of the alkaline waters found in the soil of certain parts of Western Canada was brought forcibly to the attention of engineers and builders when structures of great importance and magnitude, situated in the Prairie Provinces, were found to be slowly but surely disintegrating under this destructive agency. A brief survey showed that structures involving millions of dollars were endangered, and the problem was so

serious that certain engineers of standing decided that until more was known concerning the action of these waters concrete could not be safely used under conditions where alkali ground water would be encountered. The importance of such a conclusion is evident and the Engineering Institute of Canada, considering the problem to be one of the most important facing the profession in Western Canada, decided to appoint a committee to make a thorough investigation of the whole question. Prof. C. J. Mackenzie, M.E.I.C., of the University of Saskatchewan, was appointed chairman of the committee in January, 1922, and the expenses of the investigation were provided for during a period of three years by annual subscriptions during this period from the following bodies:—

Research Council of Canada	$5,000 00
Province of Saskatchewan	3,000 00
Province of Alberta	1,000 00
Canada Cement Company	3,000 00
Canadian Pacific Railway	1,000 00
City of Winnipeg	200 00
	$13,200 00

It was decided to carry on the investigation along two lines (*a*) physical field tests (*b*) chemical research. The blocks for the field tests, numbering about 250, were made at Saskatoon and were placed during the summer of 1921 at selected sites near Winnipeg, Calgary and Saskatoon. The field work was conducted under the direction of Professor Williams, of the University of Saskatchewan. The chemical research has been placed under the direction of Professor Thorvaldson, who is devoting his entire time to the problem for a year, and is assisted by five chemists. A considerable amount of work has been done elsewhere on the physical side and investigators elsewhere are to-day working on various phases of the chemistry of the problem, but the work being done by this committee is the only comprehensive investigation which is being carried on anywhere, aiming at a thorough understanding of the causes which underlie the wholesale destruction of valuable concrete structures in Western Canada. It is not expected that any results will be available for publication till the expiry of another year at least, since the field specimens have to be exposed to alkaline waters of the soil for that period before an examination is made. The research work of the chemists, furthermore, is only in its preliminary stages.

2. *The Preservation of Iron Pipes from Corrosion by Alkaline Waters.*—To investigate the causes of the corrosion of iron piping and other iron structures buried in the soil in the western provinces, the sum of $1,700 was granted to Prof. John W. Shipley, of the University of Manitoba. This corrosion, which causes a very large annual loss in these provinces, is due to the action of soil waters, but what chemical action takes place is not known. This must be ascertained before preventive methods of treatment can be introduced. Prof. Shipley, before receiving this grant, was engaged on this problem for over a year at his own expense, and, from the results he has obtained so far, he is confident that the causes of corrosion can be definitely ascertained.

3. *Determination of the Cause and Treatment of Soil Acidity.*—For the purpose of making a thorough study of the cause and treatment of acidity in the soils of Quebec and New Brunswick, $2,000 was granted to Principal Harrison, of Macdonald College. This condition, which is common in the soils of eastern North America, interferes seriously with the growth of alfalfa, red clover and probably, to some extent, with the majority of useful crops. The numerous methods proposed for the determination of the quantity of lime

required to correct the acidity of a given soil (the "lime requirement" or "lime absorption coefficient") have yielded discordant results. Recently, evidence has been advanced to show that the concentration of the hydrogen ion in the soil solution has an important influence upon the growth of certain plants and it is contended that measurements of this concentration are of more importance than those of the quantity of titratable acid in the soil and lead to more reliable estimates of the lime requirement. Equipment for the electrometric and colorimetric measurement of hydrogen ion concentration has been purchased, and with the co-operation of the Quebec Department of Agriculture a few samples of soil have been collected in various parts of the province. Work began on November 1, 1921, using the samples on hand in comparing methods, with a view to selecting one or more, for use on a larger number of samples, which will be collected during the spring and summer. It is hoped that eventually provision may be made for supplementing this chemical work by culture experiments and field tests.

4. *A study of the Crushing Action in Ball Mills.*—Professor H. E. T. Haultain, University of Toronto, received a grant of $400 to continue his work done during the past two years in attempting to analyse the paths of the balls in ore crushing tube mills, by means of photography. Some five hundred photographs were taken, and a definite advance in the understanding of the process was made. The attempt was then made to secure quantitative results in connection with certain operations which the photographs had illustrated, and the work now in progress promises to give further valuable results. This research has been much aided by a film made with an ultra-rapid camera, taking 120 photos per *second*, which was shown and explained by Prof. Haultain at the meeting of the Canadian Institution of Mining and Metallurgy, held in Ottawa last spring.

5. *Determination of the Character of the Bacteria found in Milk and Butter.*—A grant of $400 was made to Professor Wilfrid Sadler, Department of Dairying of the University of British Columbia, for the completion of his investigation into the character of the bacteria and other germs found in milk and butter. The studies made throw much light on the bacterial flora of graded butter and suggest the importance of the water supply as a possible agency of contamination. They emphasize the possibility of bacterial recontamination subsequent to the pasteurization of the cream, indicate the necessity for bacteriological control in the management of cream and the manufacture of butter, and define cases where specific deterioration of grade has been eliminated or rendered less acute by putting into practice the advice given as a result of the laboratory findings.

6. *The Cultivation of Drug Yielding Plants in British Columbia.*—To ascertain the possibility of cultivating economically in British Columbia several essential oil and drug yielding plants, a grant of $850 was made to Professors R. H. Clark and J. Davidson, of the University of British Columbia. The investigations made indicate that the results obtained by storing the bark of the Cascara Sagrada for three years previous to use, can be produced quickly by chemical means; for this purpose, the bark is submitted to the action of hydrogen peroxide, and tests made at the Vancouver General Hospital with bark so treated have been satisfactory. The Cascara Sagrada wood was next examined to see if it contained enough active constituent to pay for extraction: solutions are being tested at the Vancouver General Hospital and by the Parke, Davis Company, Detroit. A preliminary report from the hospital shows the surprising result that the wood is practically as active as the bark, and this result, if fully confirmed, will mean a wonderful conservation of the fast

disappearing Cascara tree, as the bark does not constitute more than 5 per cent of the tree. Investigations of British Columbia Digitalis Purpurea indicate that the strength of the extract compares most favourably with standards. Hydrastia Canadensis (Golden Seal), Mentha piperita, Mentha spicata, Polygala senega (Seneca Snake Root) and other drug plants are being grown at the University experimental farm. Investigations have also been made into the Salicin content of British Columbia willows and poplars, and the Tanin content of Pacific Coast conifers.

7. *An Apparatus for Determining the Amount of Oil in Shales.*—Mr. Louis Simpson was granted $300 to enable him to purchase a portable apparatus for the preliminary testing of oil shales. As a result of work carried out in New Brunswick, he has designed an apparatus to reduce the time and the expenditure of gasoline required in making such tests.

8. *Investigation into the Relations of Infra-red Rays.*—Professor J. C. McLennan was awarded a grant of $1,500 to enable him to continue his investigations concerning the relations of the infra red rays to the structure of atoms and he has made a special study of the ionization of atoms of mercury. The spectrum of luminous mercury has been photographed far into the infra red rays up to 11,000 Å.U. the limit of visible light being about 7,000 Å.U. In particular it has been shown that the wave length λ 10,140 Å.U. is not absorbed by non-luminous mercury vapour, indicating that the resonance and ionization potentials are definite magnitudes and are equal respectively to 4.9-10.2 volts. Previous to this research there were indications that mercury atoms had two resonance and two ionization potentials. The research has shown exactly how much energy must be expended to ionize a given quantity of mercury vapour. This information is very useful in connection with the problem of determining the energy required to be expended in disrupting atoms and releasing the atomic energy locked up in them.

9. *Research on Ultra-violet Light.*—A grant of $500 to Professor A. L. Hughes, Queen's University, for purchase of a specially designed motor generator, to study the gap in ether waves between ultra-violet light and X-rays. Ultra-violet light of wave length as short as 200 x 10 cms. has been recently demonstrated. X-rays have a wave length shorter than 12 x 10 cms. and the properties of X-rays of wave lengths from 12 x 10 cms. to 0.1 x 10 cms. have been studied in some detail. Radiation of wave length between that of the softest X-rays and that of the most extreme ultra-violet light undoubtedly exists, but hitherto has not been produced. It is the purpose of this investigation to explore this region. The behaviour of matter toward radiation in this region merits investigation, as the results with ultra-violet light and with X-rays suggest interesting effects. There are certain fundamental differences between the method of production of light and of X-rays. It is important therefore to investigate whether, or not, these differences merge into each other in the unexplored region. These results should be of value in giving information about the structure of the atom, particularly concerning the outer boundary of the atom, and should also give information as to the bearing of the Quantum theory on these radiations.

10. *Research on Sugar and Starch in Indian Corn.*—A grant of $250 was made to Professor H. F. Roberts, of Manitoba, to meet the expenses of an investigation on the inheritance of the capacity to form and store up sugar and starch in the endosperm of different varieties of Indian Corn. This investigation, which will involve a large number of chemical analyses, is expected

to yield results of interest and value in connection with the cultivation of Indian Corn in Canada. Such work has not formerly been undertaken either in Canada or elsewhere.

11. *Research on the Reduction of Complicated Sulphide Ores in British Columbia.*—During the year, Mr. Horace Freeman continued his researches on the reduction of complicated sulphide ores and made very substantial progress toward the development of a new process. This investigation has reached the stage at which the process should be tested on a large scale and it is expected that arrangements to this end will be made before long.

These complicated sulphide ores occur at so many places and in such large quantities in British Columbia that a new and thoroughly satisfactory commercial process for their reduction and the separation of the metals which they contain would be of great value to the province.

IV. THE STANDING ASSOCIATE COMMITTEES

1. *The Associate Committee on Mining and Metallurgy.*—This committee has devoted its attention more particularly to the question of the utilization of the low grade iron ores of the Dominion. This is the most important problem which confronts the iron industry of the Dominion, for while very little high grade iron ore has been discovered in Canada, there are immense deposits of low grade iron ores which, if some method can be devised of smelting them profitably, represent an immense accession to the raw materials available for industry within the borders of the Dominion. The committee, therefore, shortly after it was constituted, appointed a sub-committee under the chairmanship of J. G. Morrow, Esq., to make a thorough study of this question. This sub-committee consists of the following members:—

J. G. Morrow, Esq., Chairman.
Frank D. Adams, D.Sc., LL.D., F.R.S.
Lloyd Harris, Esq.
Geo. A. Guess, M.A.
Arthur Surveyer, B.A.Sc.
J. B. Tyrrell, B.Sc., M.A.
Th. Denis, B.Sc.
H. E. T. Haultain, C.E.
A. Stansfield, D.Sc., F.R.S.C.
A. Maillhiot, B.A.Sc.
C. V. Corless, M.Sc., LL.D.

The sub-committee first turned its attention to the possibility of profitably smelting titaniferous iron ores, of which many deposits, some of them of large extent, are known in various parts of the Pre-Cambrian area of Ontario and Quebec. Several attempts have been made to smelt these ores in Canada but without success. The results of the experience of the blast furnace superintendents in charge of these operations were obtained and a visit was then made to Port Henry, N.Y., on lake Champlain, where these ores had been smelted at one time. Here a complete examination was made of the records of the ore, fuel and flux charges, as well as of the blast pressure, tonnage produced, slag and iron analysis, etc., and the sub-committee had the advantage of being able to discuss the whole problem with the men who had carried out the work. A visit was then made to Mineville, N.Y., another point in the same neighbourhood, where the concentration of local ores, costs, tonnages, etc., were studied. As a result of these and other studies the sub-committee reached the conclusion that few if any of the titaniferous iron ores of Canada could under present conditions be profitably smelted on a large scale in competition with the non-

titaniferous ores which are available. The Committee then took up the question of the utilization of the large bodies of low grade iron ore which occur in various parts of the Dominion. Such ores to be used must be "beneficiated," that is to say they must be submitted to some process whereby the barren mineral matter mixed with the ore is partially removed and the percentage of iron in the ore is correspondingly increased. One of the commonest methods of "beneficiation" is to crush the low grade ore, concentrate the oxide of iron by some mechanical or electrical process and briquette the purified material. Another process which has been recently invented and promises to be still more efficient is that known as the Jackling Process. This is now being tried out on a very large scale on some low grade iron ores occurring in the Mesabi iron range of Minnesota. These ores resemble rather closely some of the low grade iron ores of Canada, which lends a very marked interest to these experiments in the present connection.

The sub-committee went to Minneapolis and Duluth, and made a careful examination of the trials of the Jackling Process which are being carried out at these points. They also visited the plant at Babbitt, where about four million dollars is being spent in the erection of a plant for the operation of this process. It is believed that this Jackling Process, if it works out as successfully as it promises to do, will be directly applicable to many low grade iron ores in Canada. The committee then visited Sellwood, Ont. (Moose mountain). After carefully studying the ores of that locality, it was decided to send a large shipment of this ore, after concentrating and briquetting, to a blast furnace for an actual trial on a large scale. This trial could not be carried to a successful conclusion at the time, but it will be made during the year 1923 by the aid of a grant from the Ontario Government.

The sub-committee has also studied the question of the utilization of the large deposits of low grade siderite ores which occur in certain parts of Eastern Canada. While a certain measure of success has been attained by improving the grade of these ores through roasting, much yet remains to be done to make this process a complete success. Satisfactory results, however, can only be obtained by researches carried out on a large scale and entailing large expenditures.

In conclusion, the sub-committee is convinced that Canada possesses large bodies of iron ore but these require treatment or beneficiation before they can be profitably worked. The decreasing iron content of the Minnesota ores, proportionately increases the value of this Canadian ore and will eventually create another Canadian industry in which our transportation system will also play its part. The sub-committee is also convinced that the future of our iron ore industry is associated with large tonnage blast furnace pig iron production rather than with the smaller tonnage which could be secured by electric smelting. Large tonnages of ore must be mined and beneficiated to compete with the Lake Superior ore now imported from the United States.

2. *The Associate Committee on the Nutritional Problems of the Fox Breeding Industry* has continued its investigations and has arrived at tentative conclusions on the following problems:—

The proper maintenance ration for the ranch fox.

The minimum protein requirement of the ranch fox.

Food requirements during (*a*) breeding season, (*b*) gestation period, (*c*) lactation period.

Growth curve and food requirements of pups.

Influence of diet on production of fur.

Digestibility coefficients of some constituents of diet.

These experiments have been followed with great interest and generously supported by the various breeder's associations, and a report on the work, entitled "Food Requirements of the Ranch Fox," by Mr. G. Ennis Smith, Biochemist in charge of the ranch, has had a wide circulation.

The Council has also issued a Bulletin by Professor A. Hunter, entitled "Some Problems of the Fox-Raising Industry." The results of the most recent investigations of the Associate Committee will be found in Appendix C of the present report. It is believed that results of very direct benefit to the industry will accrue from the valuable work which is being done by this Associate Committee.

3. *The Associate Air Research Committee.*—This committee has devoted its attention chiefly to the consideration of the influence of the intense cold of a Canadian winter on flying. Among the special problems studied by the committee were:—

The effect of low temperatures on the diaphragms of recording instruments.

The strength of riggings, steam line wires, etc., at low temperatures.

Anti-freeze mixtures.

The action of intense cold on lubricating oils.

Snow friction on runners.

4. *The Associate Committee on Flax.*—This committee has been engaged in determining whether Canadian flax straw, which is available in large quantities in the western provinces, could be utilized for the manufacture of paper. Failing the requisite facilities, in Canada, samples were sent to the Bureau of Standards, Washington, where, by the courtesy of the officials, trials have been made which indicate that high grade papers suitable for a variety of purposes may be made from this raw material.

5. *Associate Biological Committee.*—The research work of this committee was carried out by Principal Harrison, of Macdonald College, and his assistants. An extended account of an investigation by Dr. Harrison into the causes of the red discolouration of cured codfish and the means of preventing this, appeared in the Transactions of the Royal Society of Canada and a more popular statement was published as Report No. 11 of the Research Council which appeared in 1922 under the joint authorship of Principal Harrison and Miss Margaret E. Kennedy, many copies of which were distributed to persons engaged in the fishing industry of the Maritime Provinces.

Principal Harrison, assisted by Dr. E. G. Hood and under a grant from the Research Council, then commenced what has proved to be a most important investigation into the *Discolouration, Smut or Blackening of Canned Lobster.*

An experimental laboratory was established in the neighbourhood of a canning factory at Rustico, P.E.I., owned by the Portland Packing Company. Arrangements were made for securing the necessary lobsters, and the American Can Company placed at Dr. Harrison's disposal some three thousand quarter-pound cans. The work accomplished during the lobster season consisted of—

1. Heat Penetration Studies, which showed that the length of time necessary to bring the contents of the cans to boiling temperature was:

For 4 ounce cans, 30 minutes.
For 7 ounce cans, 40 minutes.
For 16 ounce flats, 95 minutes.

For cans placed in a retort at a temperature of 240°F., the time required to bring the temperature of the contents to 240°F. was:

For 4 ounce cans, 15 minutes.
For 7 ounce cans, 20 minutes.
For 16 ounce flats, 60 minutes.

2. A long series of experiments was started in connection with tin cans made from plate carrying various weights of tin as follows:—

(*a*) Coke quality, approximately 1·5 pounds of tin per base box.
(*b*) Kanner's special quality, approximately 2·0 pounds of tin per base box.
(*c*) 2a. Charcoal plate, approximately 2·5 pounds of tin per base box.
(*d*) 3a. Charcoal plate, approximately 30 pounds of tin per base box.

Experiments were also made with the coke enamel cans.

3. Other experiments were started with lobsters put up under the following conditions:—

(*a*) Dead lobster, either long delayed between catching and boiling, or lobsters which have died in the cars or crates where they have been kept in sea water for twenty-four hours or longer.
(*b*) Reboiled meat in shell.
(*c*) Coagulated blood adhering to meat for a long period of time.
(*d*) Boiled lobster kept in factory over night or over week-end.
(*e*) Delayed on cooling table when in shell.
(*f*) Delayed tail meat, as a result of running out of claw meat.
(*g*) Delay in cans previous to sterilization.
(*h*) Tests of various kinds and amounts of pickle.
(*i*) Comparisons of cans with and without parchment or paper linings.
(*j*) The influence of exhaust on cans and meat.

4. The acidity and alkalinity of a large number of lobsters were ascertained. The method used was by determining the hydrogen-ion concentration by colorimetric tests and occasionally by the potentiometer.

Bacteriological tests were also carried out in order to obtain information as to the character of the bacteria in spoiled and normal cans. The thermal death point of many spore-forming organisms was determined.

A large pack was put up using a pickle made with varying quantities of acetic acid. After a sufficient number of cans were packed to allow of monthly examination for eighteen months, they were crated and expressed to the laboratory at Macdonald College, and every month cans representing each kind of experiment were opened and examined chemically and bacteriologically.

In September of 1922, a similar series of experiments was carried out at Borden, P.E.I., under somewhat different conditions. An outstanding feature of the work here was the discovery that fall caught lobsters gave reactions very different from those caught in the spring. The hydrogen-ion concentration of these lobsters was considerably higher than in those caught in the spring, and the probable explanation for this curious phenomenon is the changed reaction of the lobster at the moulting period. At this time the lobster shell is very thin, the meat somewhat watery, and the live lobster actively growing and adding calcareous matter to its shell. In all probability this material is kept in solution by an acid fluid.

Series of experiments similar to those carried out at Rustico were carried out with the fall catch. Dr. Harrison also experimented with a pickle containing citric acid and repeated the acetic acid tests.

During the remainder of the year these cans were examined monthly, but as the packers claim that cans should be kept at least one year and possibly eighteen months, before final results are determined, it seems advisable not to give the detailed results of these experiments in progress at the end of March, 1922, but to defer the full report until eighteen months have lapsed from the date of packing. A report of this character is now being printed under the supervision of the Honourary Advisory Council for Scientific and Industrial Research, and it is suggested that all interested in this investigation await the publication of this report. Suffice it to say here that the results have been

extremely satisfactory, and Dr. Harrison is of the opinion that by following out certain methods advocated in this report it will be possible for lobster packers to ensure their pack remaining in perfect condition even after eighteen months' storage.

6. *The Associate Committee on Physics and Engineering Physics* met in Toronto in January and again in Ottawa in May. An account of the work of this committee is given in Appendix B.

7. *The Associate Committee of Chemists* met in Montreal in August and discussed the following subjects, which are of special importance to Canadian industry at the present time:—

The standardization and certification by Government of materials for export.
The importance of the authorization by the Government of a large number of denaturants for alcohol to be used for various industrial purposes, and, particularly, a denatured alcohol containing only five per cent of methyl alcohol, which is now extensively used in the United States.
The establishment of an industry in the growing of Canadian medicinal plants, more specially in British Columbia, where the conditions appear to be especially favourable.
Research in the packing industry.
The deterioration of iron and steel in alkaline soils.

8. *The Associate Food Research Committee.*—The work of this committee has been carried on under the direction of Dr. A. Bruce Macallum and deals chiefly with the important subject of vitamines and the indication of the amount of vitamine present in any material by determining the rate of growth of yeast cells in the medium. An apparatus for the removal of carbonic acid from the culture media has been devised, which will enable this relation to be more accurately studied than has been possible heretofore.

9. *Special Committee on Industrial Alcohol.*—Dr. Ruttan, chairman of this committee, reports that the committee has been in close communication with the Department of Customs and Excise and that they have on several occasions requested the authorization of an increase in the number of denatured alcohols for use in Canada. The Associate Committee of Chemists, unanimously and strongly advocated the introduction of ethyl alcohol, containing five per cent of methyl alcohol as a denaturant; this alcohol is used in connection with 169 preparations, pharmaceutical and commercial. The Department of Customs and Excise asked for advice concerning the best composition for a bathing alcohol for use in hospitals. Several formulæ were suggested, and it was finally decided to recommend the use of 2½ per cent di-ethyl phthalate, and five grains of brucine per gallon. The properties of di-ethyl phthalate were studied, and, on Dr. Ruttan's recommendation, the department authorized this alcohol, which can be sold at about $1.10 per gallon for bathing alcohol.

V. ADMINISTRATION AND FINANCE

Dr. R. F. Ruttan, who, during the earlier portion of the year held the position of acting chairman, was succeeded in October, 1921, by Dr. R. A. Ross, who was appointed Chairman of the Research Council. Dr. Ross before the close of the fiscal year found that, owing to pressing professional duties, he was unable to remain on the Council and consequently on March 6 he resigned his membership. His resignation was accepted with much reluctance and regret

His services had been of great value to the Council and his departure was a very distinct loss. On May 30, 1922, Dr. Frank D. Adams was appointed to succeed Dr. Ross as chairman.

Last session Parliament voted the sum of $120,000 for the use of the Council, being the same amount as allocated for the previous fiscal year. The following comparative tables show the manner in which these sums were expended during the years in question:—

	1921-22	1920-21
Fellowships	$ 8,700 00	$ 5,800 00
Studentships	8,100 00	7,125 00
Bursaries	10,625 00	4,000 00
Assisted Researches	24,617 28	51,779 05
Salaries and general expenses	29,801 82	30,935 07
Travelling expenses	7,419 27	9,938 36
Refunded to Receiver General	20,436 63	10,422 52
	$120,000 00	$120,000 00

In 1921-22 the sum of $20,000 was loaned by the Research Council to the Lignite Utilization Board to enable this board to continue its experimental work on the carbonization and briquetting of the lignites of southeastern Saskatchewan, which was being carried on at Bienfait, near Estevan, in that province. This work had been temporarily suspended awaiting the granting of a further Government subsidy. The subsidy in question, however, was not received by the Lignite Utilization Board until after the close of the fiscal year, and therefore when refunded, the sum loaned was no longer available for the purposes of the Research Council and had to be returned to the account of the Receiver General.

VI. THE NATIONAL RESEARCH INSTITUTE

In the spring of 1921 the Government introduced into the House of Commons a Bill—on the lines of a draft Bill proposed by the Research Council—for the establishment of a National Research Institute. This Bill passed the House by an almost unanimous vote, receiving the third reading on May 10, but was rejected by the Senate. The House of Commons then passed a vote of $100,000 for the purpose of preparing the necessary plans and commencing the erection of the Institute, but under the circumstances of the case the Research Council was not able to avail itself of the grant in question.

In the fall of the year that Government was defeated and it was judged inadvisable for the Research Council to press for the reintroduction of the Bill in the session of Parliament which followed almost immediately upon the new Government taking office, but rather that the Bill for the establishment of the National Research Institute with such alterations, if any, as were deemed advisable, should be introduced in the following session, that of 1922-23, when it could receive the full consideration which it deserved.

As has been already stated, the Research Council considers the erection of a National Research Institute to be necessary to the further progress of the work for which the Government brought the Council into existence, namely, the furtherance of Scientific and Industrial Research in the Dominion of Canada.

Having developed its work on the lines set forth in the preceding pages, the next step which the Council should take is to organize in the various industries of Canada Guilds of Research, as has been done so successfully in no less than twenty-four industries by the Research Council of Great Britain. The

Research Council in the Mother Country, having received a grant of £2,000,000 and dealing with industries which are developed on a much larger scale than in Canada, has arranged for the creation of a separate research laboratory for each industry, in which the special problems facing that industry may be studied and solved, and has assisted these separate laboratories by special grants of money supplementary to those provided by the respective industries themselves. In Canada this is impossible since the funds at the disposal of the Research Council of Canada are insufficient and the industries are not as a general rule in a position to provide such laboratories without direction and assistance.

The establishment of a National Research Institute would, it is believed, meet Canadian conditions. In it the Government could make its contribution, in co-operation with the several industries of the Dominion, by providing ample laboratory accommodation for all investigations and two or three highly trained research workers of wide knowledge and experience, under whom investigations for all the industries might be carried out by chemists, physicists, etc., whose salaries would be defrayed by the several industries by whom they were engaged for the solution of their special problems. Thus the Government would co-operate with the industries—supplying the laboratories or workshops, with their equipment and the necessary direction—while the several industries would provide for the payment of the investigators and a portion of the expenses of conducting their respective researches. This plan presents some features of that adopted by the Mellon Institute of Pittsburg and others which are found in the work of the Bureau of Standards at Washington, or in the National Physical Laboratory in London. In this National Research Institution-provision might also be made for research in pure science and for any other work which might be assigned to it by the Government.

As has been stated in the Report of the Administrative Chairman of the Research Council for the year ending March 31, 1921:—

> "Elsewhere Research Institutes have been or are being founded. Of those already in operation there are the National Physical Laboratory of Great Britain, the Bureau of Standards with its Industrial Research Institute at Washington, the Commonwealth Institute of Science and Industry for Australia, the Cawthron Institute for New Zealand, the National Institute of Japan, the Physikalische-Technische Reichs Anstalt of Charlottenburg, and the Chemical Institute at Dahlem, Germany, and the Research Institute at Brussels for Belgium.
>
> "Besides the Central Research Institute at Dehra Dun, India, which is to be enlarged to cover industrial research on a semi-commercial scale, the Government of India has accepted the proposal to found another central Research Institute advanced by the Chemical Services Committee of the Government. Further, the establishment of a Research Institute for Burmah is now under consideration.
>
> "The National Physical Laboratory of Great Britain, as its name implies, concerns itself with research in physical, electrical and engineering problems of all kinds and with the standardization of technical instruments and apparatus, of measurements of length, volume, weight, capacity and energy in its different forms. It, however, also undertakes researches on metallurgical problems in co-operation with the Iron and Steel Institute, the Institution of Mechanical Engineers and other technical organizations. It performs a very great service in the development of many technical processes of the industries.
>
> "The function of the Bureau of Standards was until 1919 indicated by its name. Since then it has taken on industrial research work. A building of a very large capacity and of the most solid construction,

erected in the immediate vicinity of the laboratories of the bureau and designed for engineering problems for war service, but completed only in November, 1919, was given to the bureau by President Wilson and is devoted to industrial research which will be carried on on a large scale. In it can be located a large number of industrial plants on a semi-commercial scale and some are installed therein already. All these will be engaged on problems of special importance to various lines of industry as the need for the investigation of these arises.

"The lesson for Canada is an obvious one. Almost everywhere there is a recognition of the value of scientific research as a factor in the promotion of national prosperity, scientific research, not casually pursued as was the case in the past, but organized and directed to the economic utilization of the natural resources of each country and the promotion of human welfare.

"In the United States, research, especially in connection with industry, is now being carried on on an enormous scale. There are, it has been claimed, more than 2,000 firms which maintain laboratories specially equipped and staffed to carry on research each in its own line. The Dupont Company, the Western Electric, the General Electric, the Nela Company and a number of other firms spend annually huge amounts to this end. Further, it is estimated that about $30,000,000 will have been spent in 1921 for research of which amount one-third is voted by Federal and State Governments, the remainder being derived from private sources. Research is fostered there as it is nowhere else to-day.

"The people, the Parliament, and the Government of Canada cannot be and ought not to be indifferent to this situation. The nation must not be forced in the matter of new knowledge to live on the crumbs that fall from a wealthy neighbour's table. The establishment of a National Research Institute is the first and the earliest measure that should be taken to put Canada in a position to hold her own, to develop her natural resources and thereby to permit a great increase in her population.

"The Research Institute should, as advocated by the Research Council, be under its control, subject of course to the approval of the sub-committee of the Privy Council for Scientific and Industrial Research in such matters as the appointments to and the salaries of the staff of the Institute, and the acceptance of grants, donations or bequests given under conditions by private individuals or companies to support special lines of research. The Council should be made a body corporate to administer such and other funds and to acquire and hold property of all kinds necessary for the carrying on of the work of the Institute."

The establishment of a National Research Institute in Canada has, furthermore, been very strongly advocated by no less than seventy-two of the most important and influential public bodies representing the industries of the Dominion, including the Canadian Council of Agriculture, the Canadian Manufacturers' Association, the Trades and Labour Congress, Boards of Trade all over the Dominion, as well as the Canadian Clubs of our leading cities, the scientific and technical societies including the Royal Canadian Institute, the Canadian Branch of the Society of Chemical Industry, and by every important newspaper in the Dominion from the Atlantic to the Pacific. It is hoped that in the session of 1922-23 effect will be given to the widespread public desire thus expressed and that the National Research Institute of Canada will be brought into being.

APPENDIX A

PROGRESS REPORT OF THE SUB-COMMITTEE ON UTILIZATION OF CANADIAN IRON ORES

Since the last report presented in March of 1921 at Montreal, two new members have been added to the committee—Mr. Lloyd Harris, in April, and Dr. C. V. Corless, in October. Both these gentlemen have broad experience, the former in the iron and steel industry, and the latter in the nickel industry. The committee is now composed of the following eleven members:—

J. G. Morrow, Esq. (Chairman)	Inspecting Engineer, Steel Company of Canada, Hamilton, Ont.
Frank D. Adams, Ph.D., Sc.D., LL.D., F.R.S. (Ex-officio)	Dean, Faculty of Applied Science, McGill University, Montreal, Que.
C. V. Corless, M.Sc., LL.D., M.E.I.C.	Mgr. Mond Nickel Co., Coniston, Ont.
T. C. Denis, B.Sc.	Dept. of Colonization, Mines and Fisheries, Quebec, Que.
George A. Guess, M.A.	Prof. of Metallurgy, University of Toronto, Toronto, Ont.
H. E. T. Haultain, C.E., M.I.M.M.	Professor of Mining Engineering, University of Toronto, Toronto, Ont.
Lloyd Harris, Esq.	110 Brant Ave, Brantford, Ont.
A. Mailhiot, B.Ap.Sc.	Professor of Geology, University of Montreal, 228 St. Denis St., Montreal, Que.
A. Stansfield, D.Sc., A.R.S.M., F.R.S.C.	Professor of Metallurgy, McGill University, Montreal, Que.
Arthur Surveyer, B.A.Sc.	Room 715, 145 St. James St., Montreal, Que.
J. B. Tyrrell, B.Sc., M.A., M.I.M.M., F.R.S.C.	Consulting Mining Engineer and Geologist, 534 Confederation Life Bldg., Toronto, Ont.

The sub-committee endeavoured during the year to carry out a large scale test of beneficiated Canadian ore in a Canadian blast furnace. The attempt of 1920, which involved the delivery of fourteen cars of ore to one of the furnaces was brought to an untimely end. The ore, however, has since been used in small quantities. This large scale test would have been accomplished either at the works of the Algoma Steel Corporation at the "Soo," or at Hamilton in the furnaces of the Steel Company of Canada, but for the unfortunate depression which settled upon all Canadian industries. While negotiations were as yet in progress, these furnace companies realized they had sufficient iron ore on their stock piles to serve their greatly reduced requirements, without further commitments, for the season of 1921-2. Furnaces were blown out during the year as pig iron accumulated with idle or only partially operating open-hearth departments and mills. Just sufficient ore was purchased to balance the stock on hand. The uncertain industrial outlook forced these heavy reductions.

Large sums of money have been expended by private companies on development and experimental work in an endeavour to mine and beneficiate, for blast furnace use, Canadian siderite as well as magnetite ores.

The committee visited the siderite workings of the Algoma Steel Company at the Magpie and Helen mines. A huge body of ore has been proven The

pumps at the Magpie mine are not being operated and the mine is flooded. Bush fires have swept over the Helen mine and everything above ground has been destroyed. The reopening of the mine will require the expenditure of a considerable sum of money. Much experimental work has been done on both the Magpie and Helen ores. This work covers experiments with sintering machines and with a rotary kiln plant. Considerable tonnages of ore have been put through these processes of beneficiation and more or less satisfactory results have been obtained. The costs of beneficiation have, in each case, been prohibitive when the product is compared with the competing American Lake Ores.

In the opinion of the committee these siderite ores will not be used in the immediate future.

Plans are now maturing for a trial of two hundred tons of magnetite ore from the Moose Mountain mine at Sellwood, to be put over the sintering machine of the Algoma Steel Company at Sault Ste. Marie. The ore, in the form of concentrates, is frozen and as there is no heat at the mills the tonnage cannot be obtained or the test made before May.

Shipments are expected to be made in June of this year from the beneficiation plant at Jackling, though delays have been experienced in the completion of the plant.

The work of the committee is partially held up until such time as the large scale test, referred to above, can be carried out. It does not seem possible that this can be put through until there is renewed activity in the iron and steel industry.

APPENDIX B

REPORT OF THE ASSOCIATE COMMITTEE ON PHYSICS AND ENGINEERING PHYSICS FOR YEAR 1921-22

1. MEETINGS.

Two meetings of the committee were held during the year, one on the 17th and 18th of May, 1921, at Ottawa, and the other on the 31st of December, 1921, at Toronto.

2. SUBJECTS DISCUSSED.

Among the subjects discussed the most important were:—

(*a*) University courses involving special work in physics.
(*b*) Research in marine and naval problems.
(*c*) Aeronautical research.
(*d*) A National Research Institute for Canada.
(*e*) Problems suitable for investigation in a National Research Institute in Canada.
(*f*) The Institute of Physics of Great Britain.
(*g*) Publication of papers by research workers in physics in Canada.

(*a*) *University Courses involving special work in Physics: Medical Research.*

To those who have followed recent progress in Medical Research it has become fairly clear that more rapid advances can be made if the workers in this branch of science can be induced to enter upon their investigations with a better training in the principles of physics than the majority of them possess at present. The Associate Committee having considered the matter at length decided to put forward a suggestion to the presidents and the medical faculties

of the universities of Canada, that senior medical students and recent graduates in medicine be given an opportunity of acquiring a more extensive knowledge of the principles of physics than can be obtained from the general course of lectures and demonstrations on the subject usually provided in the primary year of the ordinary medical curriculum. The suggestion has also been made, in this connection, that the medical faculties of other universities might possibly, with advantage, consider the advisability of following a procedure similar to that recently adopted in the University of Toronto, where through a series of options in the higher years of their course, senior medical students have available advanced instruction, including demonstrations in electricity, molecular physics, colloidal solutions, optics, acoustics, radiation, radiology and radioactivity. The Associate Committee has also drawn attention to another feature of the plan of training adopted at Toronto, whereby graduates in medicine may, by taking for a period of eight months, a course of post-graduate instruction in the last three of the subjects just mentioned, qualify for a special university diploma in radiology.

Courses of Instruction in Mathematics, Physics and Engineering.

Under the novel conditions that frequently prevailed during the great war, it often became necessary both for purposes of offence and defence, to invent, construct and use new devices, instruments, and apparatus that demanded for their creation the powers and knowledge of mathematicians and physicists, and for their development and use the skill and special knowledge of well trained engineers.

As examples of these developments one might cite—

(*a*) Instruments for the detection and location of aeroplanes in flight.
(*b*) Devices for the radio control of torpedoes or vessels of war travelling through water.
(*c*) Power transmission by wave motion in water confined pipes.
(*d*) Hydrophones and other devices for receiving or emitting sound waves.
(*e*) Thermionic valves for amplifying sounds, rectifying electric currents, and for producing high frequency electric oscillations.
(*f*) Piezo electric appliances for measuring and recording explosion pressures.
(*g*) Appliances for sound ranging in air and in water.
(*h*) Apparatus for the emission and reception of infra-red and ultra-violet radiations for signalling purposes, etc., etc.

Having in mind these examples of the products of research the Associate Committee is of the opinion that they are but typical of the developments that are likely to be required to be made in the near future in the course of scientific and industrial research. For research of this character workers will be required who are highly trained, not only in mathematics and in physics but in certain phases of engineering practice as well. The committee has therefore taken steps to emphasize the importance of our universities providing courses of instruction that will embrace not only thorough training in mathematics and physics, but also special training in chemistry and engineering as well.

With a view to disseminating information on this subject the Associate Committee recently prepared through a subcommittee, a pamphlet in which was set forth the fields of activity open to students who elect in our universities to study more especially the subjects of mathematics, physics and engineering.

This pamphlet has been distributed to the principals of secondary schools of Canada, and through them to the teachers in these schools and to the parents of pupils likely to attend them. The committee hope in this way, as well as in others, to add to the supply of research workers that are likely to be required in the near future to develop through their efforts the industries of Canada, and to meet the needs of the scientific life of the country generally.

(b) *Research in Marine and Naval Problems.*

In the war it became evident that navigation in the neighbourhood of rocky coasts, and in fog covered areas in the Atlantic and Pacific could be vastly improved by the utilization and development of submarine sound signalling and directional wireless and leader gear direction of ships.

Sound ranging, too, proved a valuable aid in carrying out hydrographic surveying for by means of it the master of a ship can have its position located with great exactness by night as well as by day, and in fogs as well as in clear weather.

In view of all this, your Associate Committee has given careful consideration to a number of problems connected with this important subject of increased safety in navigation.

(c) *Aeronautical Research.*

Although aeronautical research comes particularly within the province of the Associate Air Research Committee, and will, no doubt, be reported on by that body, it also comes naturally within the scope of those activities with which the Associate Committee on Physics and Engineering Physics is most legitimately concerned. The members of the Associate Committee were therefore anxious to become familiar with the problems awaiting solution in this field, and to this end Lt.-Colonel Stedman, Director of the Technical Staff of the Air Board, was invited to address the committee on problems confronting the Air Board. He pointed out that the main problems to be faced in Canada were associated with winter flying. What was wanted was an engine or fuel or some modification in one or the other that would enable one to start an aeroplane flying in cold weather, whenever one wished to do so. He also pointed out that new types of radiators were required and that suitable anti-freeze mixtures were urgently needed. As flying boats could be used over the greater part of Canada in summer these would require to be suitably modified for winter flying. Research in the direction of making such modifications was likely to lead to useful and important results.

Lt.-Colonel Stedman also pointed out that research in the design and construction of altimeters was urgently required.

(d) *A National Research Institute for Canada.*

Bill No. 116, in which it was proposed to establish a National Research Institute for Canada at Ottawa, was submitted for the consideration of the Associate Committee. In dealing with the matter the members of the Committee expressed the desire to be placed on record as strongly supporting the proposal to establish such an Institute.

(e) *Research Problems.*

Following a request received from the Honorary Advisory Council for a list of problems of a character suitable for investigation in the proposed National Research Institute, the secretary of the Associate Committee brought the matter to the attention of the members, with the result that the titles of more than eighty suggested researches were sent in to the Council. These dealt with matters relating to heating and ventilation, standardization of weights and measures, navigation, concrete and cement, building materials, fish, fish curing and preservation, aeronautics, meteorology, ceramics, fertilizers, electricity, light, radiology, helium, etc.

(f) *The Institute of Physics of Great Britain.*

Consideration was given to a proposal received from the Institute of Physics of Great Britain, that physicists in Canada join the Institute either directly as individual members or fellows or indirectly by becoming associated with the

parent Institute through the formation of a local branch in Canada. The conclusion reached in regard to the matter was to leave the question of the formation of a Canadian branch of the Institute in abeyance and for the time being to allow the physicits of Canada to act directly and independently in establishing relations with the Institute of Great Britain.

(g) *Publication of Papers.*

The Associate Committee is of the opinion that one of the most pressing needs of the physicists in Canada is a journal suitable for the application of the results of their investigations.

After inquiry and discussion the conclusion was reached that it would be impossible to finance the publication of a new journal devoted solely to recording the results obtained in research by physicists in Canada. The proposal put forward to use the Transactions of the Royal Canadian Institute for the purpose was rejected as it was the unanimous opinion of the members that publication should take place more frequently than once a year. It was finally decided to suggest to the Advisory Council the advisability of co-operating with the Royal Society of Canada in an attempt to publish, at intervals during the year, the papers presented to the Society at its annual meeting in May as well as others embodying the results of investigations carried out by holders of Bursaries, Studentships, and Fellowships from the Council, and the results of researches supported in whole or in part by grants from the Advisory Council.

APPENDIX C

SECOND PROGRESS REPORT OF THE ASSOCIATE COMMITTEE ON THE NUTRITIONAL PROBLEMS OF THE FOX INDUSTRY

At its fourth meeting, on October 8, 1921, the committee decided to repeat, but upon a larger scale, the experiments described in its first progress report. To make this possible it was necessary to have more foxes and ampler accommodation. With the aid of funds provided by the Department of Agriculture the large pens existing were subdivided, two additional pens and two small dog-pens were constructed, and eight additional kennels were purchased. The foxes needed, to the number of eleven, were generously donated by Messrs. P. G. Clark, E. H. Rayner, B. Graham Rogers, the Pure Canadian Silver Fox Company—all of Summerside, P.E.I.—and Dr. A. Jamieson, Arnprior, Ont. The new season was begun therefore with twenty-four foxes, of which four were born on the ranch. It may be stated here that thirteen pups were born during that season. Two of these have died, and one adult was accidentally killed. The season of 1922 closes therefore with thirty-four foxes (eighteen miles and sixteen females), fifteen of which were born on the experimental ranch.

The diets selected for the breeding season were six in number, and were practically identical with the six diets used in 1921. Two pairs were placed on each diet. Those which had been on diets of high calorific value during 1921 were now placed on low calorie diets, and vice versa. Three only of the twelve females became pregnant and produced litters. Of these, one was on the high calorie-high protein diet, one on the high calorie-low protein, and one on the low calorie-low protein diet; the last had in 1921 produced (but killed) a litter when on the high calorie-medium diet. Of the nine pairs which failed to produce litters none of the males (six of which were adults, three pups of the previous season) has ever been known to impregnate the female. On the other hand, all males positively known to have had offspring have sired litters in both years. It